A NEW FRINGED STARGAZER (URANOSCOPIDAE: *ICHTHYSCOPUS*) WITH DECRIPTIONS OF THE OTHER AUSTRALIAN SPECIES

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Ichthyscopus nigripinnis sp. nov. is described from a series of specimens collected off the northeastern coast of Australia extending from northern New South Wales to eastern Papua New Guinea. The species appears most closely related to *I. spinosus* from northern Western Australia, with which it shares a highly developed subcleithral ridge and a partially separated anterior portion to the dorsal fin, but resembles *I. barbatus* from southern Australia more closely in coloration. The new species is distinguishable from the former by the absence of dark spots on the upper portion of the head and body and the presence of fimbriae on the horizontal fleshy ridge adjacent to the upper pectoral fin base. It is separable from the latter by its well defined, jet black anterior segment of the dorsal fin and the absence of barbels on the midline of its chin. Detailed descriptions of Australian congeners, *I. barbatus*, *I. fasciatus*, *I. insperatus*, *I. sannio* and *I. spinosus*, are also presented. A cladistic analysis of the interrelationships between Australian species of *Ichthyscopus* based on 14 variable characters supports two similar trees of equal length. An evolutionary hypothesis is presented for Australian *Ichthyscopus* based on this analysis, the current distributions of species and perceptions of past climatological fluctuations. ❐ *Uranoscopidae, Ichthyscopus, Stargazer, Australia.*

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The Australian region is remarkable for its high diversity and endemicity of fishes belonging to a large number of widely distributed marine families. The stargazer family Uranoscopidae is a good example, and no genus demonstrates it better than *Ichthyscopus* Swainson. In his study of the relationships of members of the family, Pietsch (1989, based on Mees, 1960) indicated that the genus 'apparently contains five species', all of which occur in Australia and four of which are confined to its waters. A recent examination of Australian stargazers has revealed the presence of yet another endemic species of *Ichthyscopus* and has shed further light on the interrelationships of taxa in this genus.

Mees (1960) reviewed *Ichthyscopus*, along with other Australian uranoscopid genera known to him at the time. Three additional species of *Ichthyscopus* and a comparison of Whitley's (1936) *I. sannio* with *I. lebeck* (Bloch & Schneider, 1801) were presented. The study has since been regarded as the definitive treatment of the genus but provides only minimal descriptions of even Mees' taxa. The purpose of this paper is to present a description of a recently detected sixth Australian species of *Ichthyscopus*, to provide more detailed descriptions of its 5 Australian congeners, and to comment on the interrelationships of the species currently recognised in the genus and the associated biogeographical implications.

METHODS

Counts, measurements and terminology mostly follow Hubbs & Lagler (1947). The body depth was measured at the origin of the dorsal fin, following Bruss (1986). The head width was taken at the middle of the operculum. Orbital diameters were recorded both as longitudinal and transverse measurements. The eye diameter is the longitudinal dimension. The interorbital distance refers to the distance between the mesial rims of the left and right orbits at the center of the orbit, while the interorbital fossa width is the distance across the interorbital fossa at the level of the center of the orbit. The length of the cleithral spine was measured along the axis of the spine from its tip to the point it disappears beneath the opercle.

The anatomical form of the elements (spines versus soft rays) at the anterior end of the dorsal

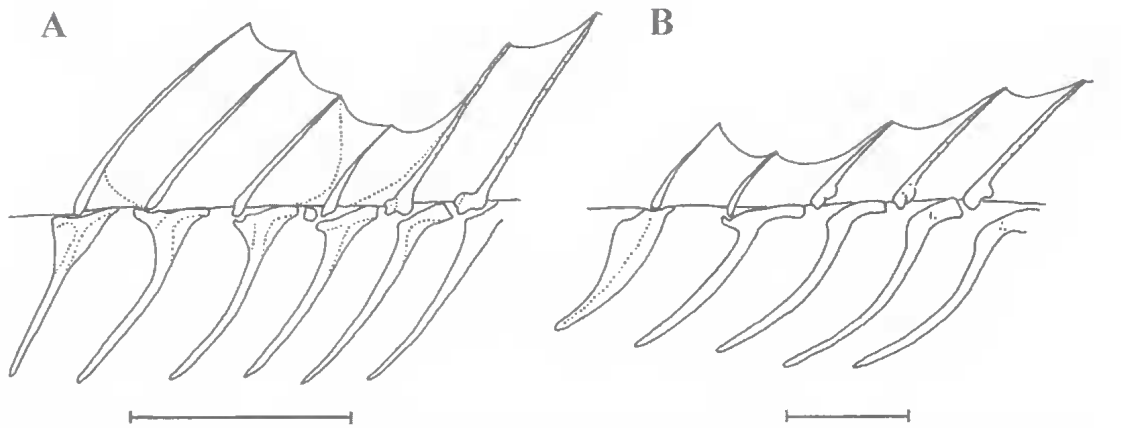

FIG. 1. Anterior end of dorsal fin with associated proximal pterygiophores in: (a) *Ichthyscopus nigripinnis*, holotype, QM I30217, 110mm SL, and (b) *I. barbatus* SAM388, 196mm SL. Scale bars = 10mm.

fin is extremely difficult to recognise on external examination, or for that matter, with the use of radiographs. Consequently, though the number of spines regularly separates this species from congeners, it is of dubious use as a key character. Spines and soft rays do appear to be consistent in their relation to supporting proximal pterygiophores, with spines regularly carried anteriorly above the upright shaft of the pterygiophore and soft rays articulating with a posterior extension of the 'head' of the proximal pterygiophore (Fig. 1). The last dorsal spine and first soft ray of the dorsal fin are supported by the same pterygiophore. The first soft ray may also be recognised by its expanded cap-like proximal end. Values of '.5' in reference to dorsal and anal fin formulae refer to a small ray-like element close behind the otherwise last ray of the fin. In most cases the former is associated with a small proximal pterygiophore and may represent a complete, albeit small ray, and not a branch of the terminal ray separated to the base as occurs in many other higher bony fishes. The extremely fleshy nature of fin coverings makes the accurate determination of supporting element numbers impossible without the use of radiographs or clearing and staining techniques. Although radiography is useful for revealing the fin ray compliments of unpaired fins, the technique will not show the numbers of elements in paired fins because of underlying bony structures. An examination of cleared and stained material indicated that external counts on pectoral fins are likely to miss the dorsalmost hair-like modified first ray positioned closely in front of the rather short unbranched 2nd ray. Likewise, the spine of each pelvic fin is short, embedded at the base of the fin and virtually invisible from external examination. Scale row counts include smaller scales in less well defined rows on upper corner of caudal peduncle.

Institutional acronyms used to denote collections in which examined specimens are lodged follow the standardised list of Leviton et al. (1985). Numbers enclosed by parentheses following catalogue numbers in lists of type specimens and material examined refer to the number and size range (mm SL) of specimens. In the detailed description of the new species, information pertaining to the holotype is presented first and variations observed in paratypes follow in parentheses. Meristic values for internal features were obtained using lateral radiographs. Values for pleural ribs have been omitted as anterior elements were obscured by the pectoral fin and its basal skeleton in those specimens examined. Pietsch (1989) reported the genus to have 2 or 3 ribs anteriorly and 1 posteriorly. This study confirms that Australian species of the genus consistently have a pair of pleural ribs associated with the haemal spine of the 2nd caudal vertebra, but does not record the number and positions of ribs anteriorly.

Selected meristic and morphometric characters are provided for 6 species of *Ichthyscopus* in Table 1. The 14 variable characters listed in Table 2, with the character states occurring in the 6 Australian species of *Ichthyscopus* and the more primitive uranoscopid genus *Uranoscopus* (as determined by Pietsch, 1989), were compared using PAUP computer software to derive the most parsimonious hypothesis of relationships.

KEY TO AUSTRALIAN SPECIES OF *ICHTHYSCOPUS*

1. Outer surface of cleithral spine almost entirely exposed, ventrally fringed fleshy covering confined to lower margin, not extending posteriorly beyond spine tip; approximately 52-84 obliquely angled scale rows on sides; body with 5 or 6 equally spaced, broad dark bands dorsally . . . . . *I. fasciatus*

   Cleithral spine entirely enveloped by ventrally fringed fleshy covering, extending as tapered flap well posterior to spine tip; scales absent or in 28-59 (rarely more than 53) obliquely angled rows on sides; body with dark bands, saddles, spots or mottling dorsally, but not as described above 2

2. Body without scales; body dorsally with 5 dark edged saddles (small specimens) or with 9 or 10 dark edged vertical bands (large specimens) . . . . . *I. insperatus*

   Body with scales appearing as obliquely angled folds along sides of body; body dorsally with 2 dark saddles, numerous dark spots or dark and pale mottling 3

3. Fimbriae on lips with 1 or 2 rows of evenly spaced lateral branches on either side in adults; each side of lower jaw with 12-21 rather short conical teeth; dorsal portion of body dark with distinctly pale mottling . . . . *I. sannio*

   Fimbriae on lips without lateral branches in adults; each side of lower jaw with 4-14 prominent slender canines, posteriormost often noticeably longer than those anteriorly; dorsal portion of body with dark saddles or spots 4

4. Crest of horizontal fleshy subcleithral ridge anterior and posterior to upper end of pectoral base irregular, sometimes with simple papillae but lacking branched fimbriae (Fig. 2A); numerous small dark spots on upper portion of sides and head . . . . . *I. spinosus*

   Crest of horizontal fleshy subcleithral ridge anterior and posterior to upper end of pectoral base with numerous, often laterally branched fimbriae (Fig. 2B); each side of body with 2 large dark saddles or blotches dorsally . . 5

5. Dorsal fin rather dark anteriorly, its distal margin slightly concave (Fig. 1B); midline of chin with vertically aligned pair of small fleshy barbels; skin flap adjacent to ventrolateral edge of lower lip with smooth margin (Fig. 3B); posterior nostril circular (Fig. 4B); inner surface of pectoral fin almost uniformly dusky with pale distal margin and pale fleshy base. . . . . *I. barbatus*

   Dorsal fin black anteriorly, an anterior segment separated from rest of fin by a deep concavity (Fig. 1A); midline of chin without barbels; skin flap adjacent to ventrolateral edge of lower lip with arborescent margin (Fig. 3A); posterior nostril ovoid, rimming fleshy anterior gap in bony orbit (Fig. 4A); inner surface of pectoral fin with pale rays and dark intervening membrane . . . . . *I. nigripinnis* sp. nov.

Ichthyscopus nigripinnis sp. nov.
(Figs 1A, 2B, 3A, 4A, 5-7, 8A)

ETYMOLOGY. *nigripinnis*, an amalgamation of the Latin adjective *nigra* for 'black' or 'dark', and noun *pinna* for 'fin', in reference to the partially separated black anterior segment of the dorsal fin characterising this species.

MATERIAL. HOLOTYPE: QM130217 (1, 110) Queensland, Moreton Bay, 4 miles NE of Mud I., 27°17'S 153°18'E, 15m, 1 November 1994, Qld DPI Fisheries. PARATYPES: AMSIA1392 (1, 137) Qld, Bowen, registered 6 July 1923, E. Raniford; AMS IB2957 (1, 208) Papua New Guinea, Laloki R., L. Jones; AMS I20212-015 (1, 41.6) Qld, One Tree I. Lagoon, 23°30'S 152°05'E, 18-20m, 6 October 1971; AMSI 25425-001 (1, 135) NSW, off Ballina, 28°52'S 153°40'E, 36m, 14 February 1966, NSW Fisheries; AMS I31476-007 (2, 100-124) NSW, off Murwillumbah, 28°20'S 153°40'E - 28°25'S 153°41'E, 54-58m, 2 May 1990, FRV Kapala, K. Graham; AMSI31484-001 (1, 137) NSW, off Brunswick Hds, 28°26'S 153°41'E - 28°25'S 153°41'E, 53-57m, 16 February 1991, FRV Kapala, K. Graham; AMSI33571-001 (1, 81.9) NSW, off Iluka, 29°23'S 153°23'E - 29°44'S 153°23'E, 23-28m, 7 May 1990, FRV Kapala, K. Graham; AMSI33669-001 (1, 89.7) NSW, off Iluka, 29°22'S 153°23'E - 29°21'S 153°24'E, 25-28m, 14 November 1991, FRV Kapala, K. Graham; AMSI33681-001 (1, 116) NSW, off Brunswick Hds, 28°23'S 153°38'E - 28°25'S 153°38'E, 47-51m, 24 March 1992, FRV Kapala, K. Graham; AMSI37479-001 (1, 119) NSW, off Iluka, 29°49'S 153°20'E - 29°50'S 153°21'E, 34-37m, 26 May 1995, FRV Kapala, K. Graham; NMVA20079 (1, 50.4) NSW, off Iluka, 29°23'S 153°24'E - 29°22'S 153°25'E, 29-31m, 18 April 1996, FRV Kapala, K. Graham; NMVA20080 (1, 54.8) NSW, SE of Yamba, 29°39'S 153°21'E - 29°38'S 153°21'E, 25-33m, 11 September 1995, FRV Kapala, K. Graham; QMI4252 (1, 162) Qld, Moreton Bay, 3 November 1925, W. Hiddens; QMI9521 (1, 113) & QMI9522 (1, 84) Qld, Gneering Shoals, off Mooloolaba, 26°40'S 153°13'E, 36.5m, 2 February 1961, J.M. Moulton; QMI9983 (2, 86-89) Qld, 5-6 miles east of Point Cartwright, 26°40'S 153°13'E, trawl 34.7-38.4m, 5 March 1970, F. Wallace; QMI10754 (1, 100) Qld, off Maroochydore, 26°41'S 153°14'E, 25.6m, coarse sand, 29 November 1950, E.M. Grant; QMI11823 (1, 103) Qld, Northumberland Group, 20.1-54.8m, 8 August 1957, FRV Challenger, N. Haysom; QMI11908 (1, 275) Qld, Heron I., 23°27'S 151°55'E, 30 January 1951, C. Cox; QMI17169 (1, 70) Qld, Tongue Reef, 16°26'S 145°45'E, 3m, 27 October 1974, B.L. Scomazzon. OTHER MATERIAL: QMI17079 (1, 270) Qld, 7 miles east of Mooloolaba, 26°41'S 153°16'E, 29.2m, coarse sand, 30 September 1979, J. Johnson (otoliths only).

DIAGNOSIS. Dorsal fin with 3 (rarely 4) spines and 16-17.5 soft rays, the anterior end differentiated by a deep concavity in the distal margin (Fig. 1A), 4th element (usually = 1st soft ray) shortest, anterior segment distinctively black with white basal margin at least anteriorly and posteriorly; opening of posterior nostril elongate, ovoid, rimming fleshy anterior gap in bony orbit (Fig. 4A); labial fimbriae simple, smooth-edged; skin flap adjacent to ventrolateral edge of lower lip with one to numerous, simple to palmate fimbriae on margin (Fig. 3A), especially near corner of mouth; each side of lower jaw with 4-9 teeth; chin lacking barbels; cleithral skin flap nearly twice length of cleithral spine; fleshy

TABLE 1.Observed ranges for selected morphological dimensions (as percent of standard [SL] or head lengths [HL]) and meristic characters in Australian species of *Ichthyscopus*.

	I. nigripinnis		*I. barbatus*	*I. fasciatus*	I. *insperatus*	*I. sannio*	*I. spinosus*
	holotype	paratypes					
No. of specs : standard length	110	22: 41.6-275	11: 118-237	5: 102-243	6: 33.0-177	24: 45.0-431	2: 134-165
Body depth / SL	37.6	33.1-42.8	30.0-35.8	25.2-32.9	31.2-34.6	29.5-37.1	34.4-39.5
Head length / SL	36.9	30.6-42.3	29.0-34.2	30.8-34.7	30.7-37.9	30.9-36.9	36.1-41.3
Head width / SL	36.2	29.9-37.3	32.4-38.5	28.1-30.8	28.2-36.9	31.0-38.1	33.8-41.7
Orbital diameter (long) / HL	18.5	14.1-20.6	12.6-19.2	15.3-19.1	17.5-20.0	13.1-18.7	15.9-17.1
Orbital diameter (transv) / HL	16.5	11.3-18.9	11.4-15.8	11.3-14.1	12.5-15.9	10.2-16.1	12.5-14.3
Eye diameter / HL	11.8	7.9-14.4	8.2-12.7	8.6-11.2	10.3-14.4	5.7-12.7	10.2-10.8
Interorbital distance / HL	19.9	17.1-24.3	25.4-28.5	17.7-20.2	20.0-28.9	20.6-27.4	20.1-23.8
Interorbital fossa width / HL	13.0	9.8-16.8	12.4-23.1	6.2-8.7	9.1-13.6	11.2-19.8	14.3-19.6
Cleithral spine length / HL	15.3	14.4-30.9	21.8-31.9	21.7-27.4	28.0-30.6	23.8-36.5	15.7-19.3
Head shield length / HL	31.8	28.1-37.7	34.4-41.9	42.3-53.0	34.4-42.6	24.6-33.5	27.1-29.0
Pectoral fin length / SL	32.6	27.9-35.2	28.5-34.4	23.7-30.2	29.0-38.2	27.0-33.6	29.9-32.1
Pelvic fin length / SL	26.0	20.0-30.5	21.7-28.8	17.2-19.2	22.6-27.3	22.4-26.2	23.7-27.2
Dorsal fin	III, 16.5	III-IV,16.5-17.5	II, 17-17.5	I, 17.5-20	I, 18-19	II-III, 16-17.5	II, 17.5
Anal fin	16.5	15-16.5	16-16.5	17-18.5	16-17	16.5-17.5	16
Pectoral fin	14	13-16	13-15	15-16	14-15	17-18	16-17
Vertebrae	9 + 17	9 + 17-18	9 + 17-18	9 + 18	9 + 16-17	9 + 18	9 + 16
Epipleural ribs	11	7-11	8-11	9	8-9	7-9	8
Upper lip fimbriae	16	15-22	17-23	23-26	19-34	27-36	25-26
Lower lip fimbriae	50	38-56	41-52	38-45	44-49	41-51	52-55
Lower jaw teeth	4, 5	4-9	2-9	11-18	9-14	12-21	4-9
Opercular fimbriae	23, 24	16-29	21-31	11-18	15-26	12-19	21-23
Cleithral flap fimbriae	20, 21	15-24	21-28	8-14	15-21	15-22	15-18
Scale rows	46	36-51 + 0-9	28-45 + 0-10	52-84	0	47-59	38-41

horizontal subcleithral ridge continuing on posterior side of pectoral fin axis to just below free posterior tip of cleithral skin flap, forming free pointed flap posteriorly; crest of ridge fimbriate anterior and posterior to pectoral fin base; fimbriae similar in structure to those on opposing margin of cleithral flap; scales present, in 36-51 oblique rows; sides dusky dorsally, each with two large dark blotches, positioned below anterior and posterior ends of dorsal fin; pectoral fin with distinctive pale rays and black intervening membrane.

DESCRIPTION. Dorsal fin rays III, 16.5 (III or IV, 16-17.5; anterior elements slender, 4th usually an unsegmented, unbranched 'soft ray' which is difficult to distinguish from preceding spines even with use of radiographs; 5th usually segmented but unbranched; last element often smaller than penultimate element and may or may not be associated with a reduced pterygiophore making it difficult to determine if it is separate or simply a ray branched to the base); anal fin rays 16.5 (15-16.5, usually 16.5; last element as in dorsal fin); caudal fin with 12 (rarely 13) principal rays and 3 (3 or 4) unsegmented procurrent rays dorsally and ventrally; pectoral fin rays 14 (13-16; 1st element unbranched); pelvic fin rays I, 5 (spine a short spur concealed in thick skin and closely associated with 1st ray); branchiostegal rays 5;

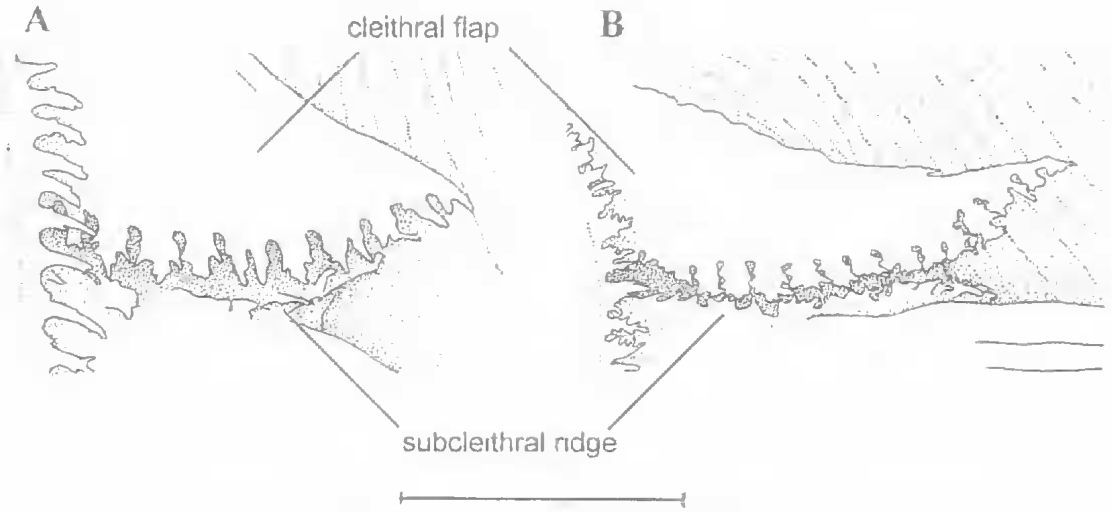

FIG. 2. Cleithral region (left side) showing fleshy subcleithral ridge in A, *Ichthyscopus spinosus*, NTMS10959-020, 134mm SL, and B, *I. nigripinnis*, AMS137479-001, 119mm SL. Scale bar = 10mm.

vertebrae 9 + 17 (rarely 9 + 18); epipleural ribs 11 (7-11, mean 9.05), situated on vertebra 4-14 (4 or 5 - 11 to 14).

Body moderately deep, compressed posteriorly; head rather square in cross section see Table 1 for morphometric data.

Head mostly encased in bone, without obvious joint lines dorsally (Fig. 6); bony surface textured with fine low vermiculations; dorsal surface mostly flat, only slightly concave posterior to interorbital fossa. Interorbital fossa rectangular, width posteriorly only slightly less than that between orbits. Orbit circular, diameter distinctly greater than that of eye. Anterior nostril small, approximately 1/4 eye diameter, tubular, partially divided into 2 openings by midposterior flap; anterior side with low rim providing notch, rim edged with moderately short simple fimbriae. Opening of posterior nostril elongate, ovoid, rimming fleshy anterior gap in bony orbit; nostril with prominent anterior flap and less prominent medial and lateral flaps, each with fimbriate edges; anterior flap functionally dividing nostril into lateral and mesial openings. Both lips with simple, smooth edged fimbriae externally, fimbriae on lower lip occasionally branched at corner of mouth; 16 (15-22) individual fimbriae on upper lip, 50 (38-56) on lower; skin flap on lower jaw adjacent to ventrolateral edge of lower lip with one to many, simple to palmate fimbriae on margin, especially near corner of mouth; inner edge of upper and lower lips also with fimbriate fringe. Upper jaw with broad band of numerous small slightly curved teeth; teeth not in distinct rows, about 3 or 4 teeth across band where broadest. Lower jaw in large specimens with 4 or 5 widely spaced straight prominent narrow canines angled back into mouth on each side, posteriormost noticeably longer than others (smaller specimens with up to 8 or 9 teeth on each side of lower jaw). Oral valve broad, fleshy, drawn upwards into a low point medially (one specimen with simple fimbriate margin). Chin smooth, without barbels. Dorsal half of opercular margin fimbriate, with 23 or 24 (16-29) individual fimbriae; ventralmost simple, those dorsally with up to 8 simple lateral branches, branches rarely subdivided; opercular margin smooth ventrally.

Cleithral spine extending posteriorly almost to above dorsal extent of pectoral fin axis. Fleshy cleithral skin flap enveloping spine extending well past this point; underside of flap fimbriate with 20 or 21 (15-24) individual fimbriae, including several simple fimbriae anteriorly beneath opercular margin; fimbriae, including that at tip of flap, with up to 9 side branches on both anterior and posterior margins, those closest to tip with the most branches; branches only occasionally subdivided into sub- branches (occurring most often proximally on flap); occasionally 1 or 2 simple fimbriae on dorsal edge of flap near tip. Narrow fleshy subcleithral ridge extending horizontally from upper angle of opercular opening to dorsal extent of pectoral fin base, continuing on posterior side of pectoral fin axis to just below free posterior tip of cleithral skin flap, forming free pointed flap posteriorly; crest of ridge fimbriate anterior and posterior to

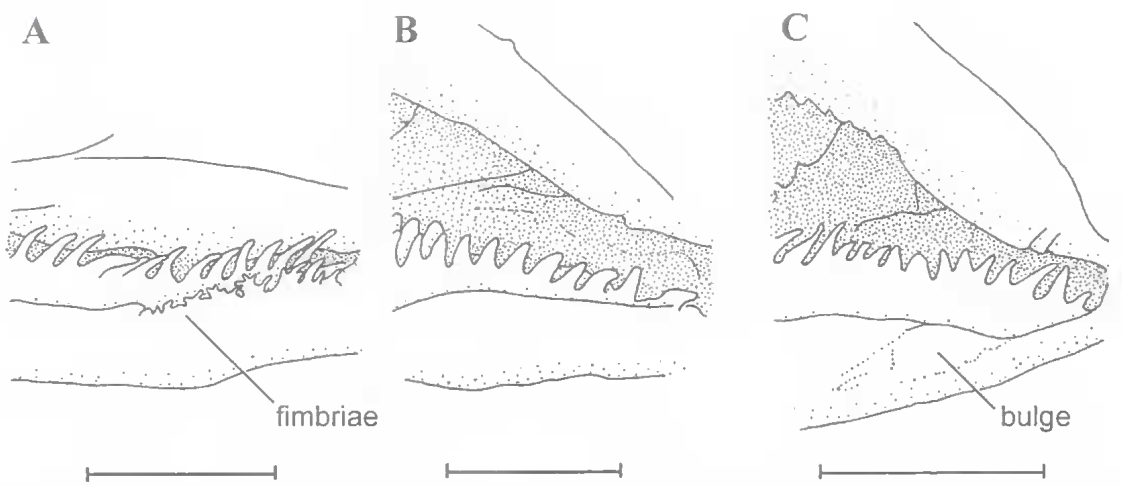

FIG. 3. Corner of mouth (left side) showing margin of skin flap adjacent to ventrolateral edge of lower lip in A, *Ichthyscopus nigripinnis*, AMSI33681-001, 116mm SL, B, *I. barbatus*, NMVA13018, 130mm SL, and C, *I. insperatus*, WAMP1858-001, 115mm SL. Scale bars = 5mm.

pectoral fin base; fimbriae similar in structure to those on opposing margin of cleithral flap (Fig. 2B). Upper half of opercle and preopercle with low surface vermiculations similar in form but finer in texture than those on dorsal cranial plates; lower halves with simple fine striae radiating ventrally. No spines associated with subopercle, opercle, preopercle or basipterygium.

Dorsal fin rather long-based and low, anterior end partially separated into short anterior segment by deep concavity; first 4 (4 or 5) dorsal fin elements relatively short, 1st longest, 4th (4th or 5th) shortest, 4th about half length of 1st and 6th. Anal fin long-based and low. Caudal fin truncate to slightly rounded with branched tips of caudal rays extending slightly beyond membrane. Pectoral fin pointed, tip of 3rd ray at point, membrane incised slightly between tips. Pelvic fins strong and fleshy, inner 2 rays longest, interradial membranes more clearly incised in remaining rays. Ventral midline with medial ventral skin flap from anterior tip of basipterygium to rear of pelvic fin base. A small rounded transverse flap posteriorly at midbase of pelvics.

Scales prominent, cycloid, rectangular, arranged in about 46 (36-51, usually 46 or 47) obliquely angled rows, occasionally two scale rows merging into one as they proceed ventrally (one specimen with scale rows on one side of body obliquely ventrad to about eleventh dorsal ray and obliquely dorsad at rear, other side of same individual with typical obliquely ventrad scale pattern); additional scales scattered on caudal base (up to 5 scales of various sizes horizontally along patch); peduncular scale rows from posterior end of anal base to distal corner of peduncle 14 (13-16). Underside of body naked anteroventral to a line between tip of cleithral skin flap and center of anal fin base. Lateral line pores in angled lines or clumps of 3-8 at dorsal end of each diagonal scale row. Nape between rows of lateral line pores devoid of scales except for a few embedded scales in a single row just mesial to row of lateral line pores on either side; sensory pores absent from nape except for those associated with lateral line, those on naked skin adjacent to posterior margin of head shield and those piercing head shield posterolaterally.

Colour in alcohol (Fig. 5) brownish grey dorsally on sides and head, creamy white below with two pairs of broad dark blotches, one below lateral line at origin of dorsal fin and behind upper end of operculum, extending onto upper edge of cleithral flap ventrally; second pair saddle-like, on and beneath posterior end of dorsal fin, extending well ventrally. Opercle, preopercle and much of maxilla creamy white; remainder of cheek, upper lip, lower lip and chin brownish grey. Dorsal fin brownish grey except for prominent black anterior segment and somewhat darker posterior saddle, black anterior segment with white margin anteroventrally and posteroventrally. Anal fin creamy white with broad dark anteriorly tapering mid lateral stripe, becoming faint at anterior end. Caudal fin with broad rather dark transverse band distally and less dark band proximally, the two separated by a much narrower pale interspace. Lateral surface of

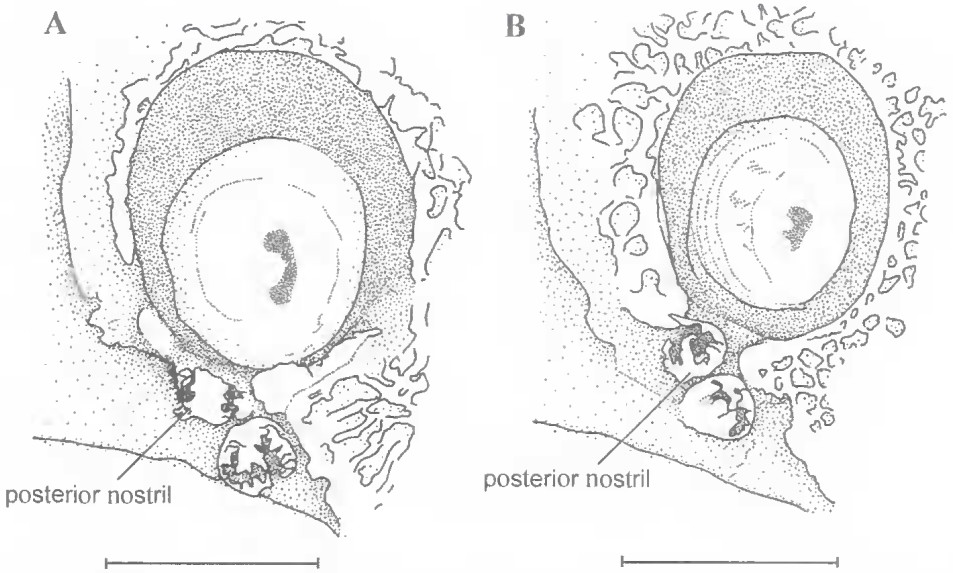

FIG. 4. Nostrils (left side) in A, *Ichthyscopus nigripinnis*, AMSI37479-001, 119mm SL, and C, *I. barbatus* NMVA13018, 130mm SL. Scale bars = 5mm.

pectoral fin with distinctly pale rays, charcoal intervening membranes and narrow pale distal margin; inner surface similar but with somewhat fainter pigmentation. Pelvic fins creamy white.

Juveniles (Fig. 7) pale below, dusky above, with narrow somewhat darker edged irregular pale longitudinal stripe immediately below lateral line under dorsal fin base and second broken stripe of similar breadth adjacent dorsal fin base; stripes breaking up and appearing as irregular blotches in larger juveniles; nape in small specimens with broad transverse pale saddle, lateral ends directed somewhat posteriorly, with margin irregularly defined by dark lines and spots; additional dark spots more or less in transverse rows anteriorly on fleshy part of nape and scattered in interorbital fossa; dorsal fin with black anterior segment as in adults and faint dusky markings posteriorly; caudal fin with broad dark distal band and faint dusky band more proximally, bands separated by a distinctly pale band with second pale band along proximal edge; pectoral fins mostly patterned as adults. Larger specimens pigmented like adults but often with two irregular narrow pale longitudinal markings on dorsal half of body variably on and posterior to posterior dark saddle and with two angled narrow pale marks on base of caudal fin.

Colour in life (270mm SL specimen), head pale tan-brown, freckled with cream spots; body slate grey with vague brownish reflections; caudal dusky, freckled white; anterior segment of dorsal fin with large vivid black spot.

DISTRIBUTION. Restricted to the coastal waters of northeastern Australia and southeastern Papua New Guinea from about the Laloki River, Papua New Guinea (9°13'S 146°55'E) to about Iluka, New South Wales (29°50'S 153°21'E) (Fig. 8A), at depths of 3-58m.

REMARKS. *Ichthyscopus nigripinnis* and *I. barbatus* are very similar, both in morphology and colour pattern. The 2 are most easily separated by the distinctive, partially differentiated, black anterior segment of the dorsal fin with 3 (rarely 4) spines in the former (mostly undeveloped with only 2 spines in the latter, Fig. 1), the shape of the posterior nostril (Fig. 4), the form of the margin of a skin flap on the lower jaw which adjoins the ventrolateral edge of the lower lip (Figs 3A,B), the nature of the crest of the fleshy horizontal subcleithral ridge and the absence in *I. nigripinnis* of chin barbels. Precise details of differences are presented in the diagnoses.

Morphologically, *I. nigripinnis* is most similar to *I. spinosus*, the 2 having the most distinctly differentiated anterior segment of the dorsal fin in the genus. The latter and other congeners differ from the new species most noticeably in having extremely different colour patterns. They are also distinguishable on the basis of various

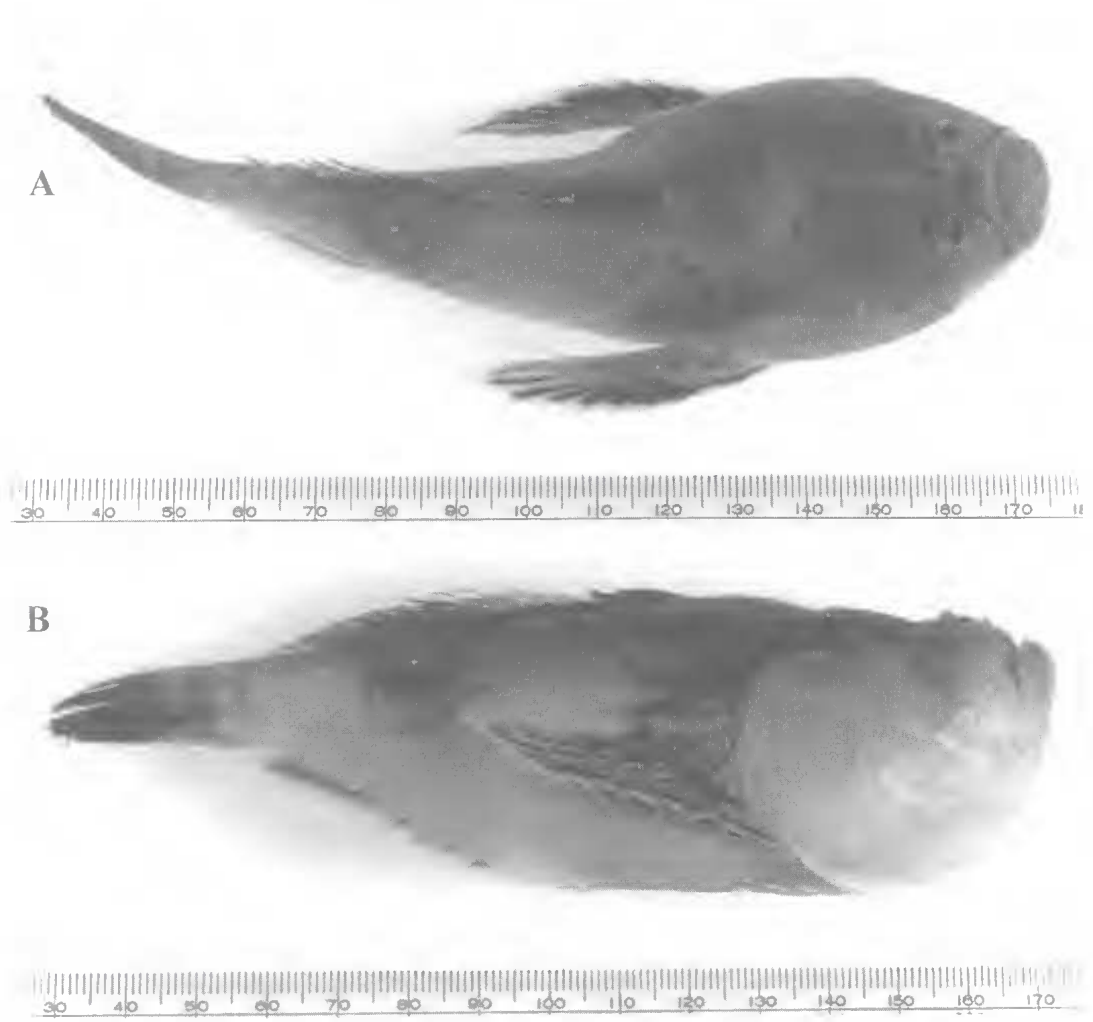

FIG. 5. *Ichthyscopus nigripinnis* sp. nov., holotype, QM130217, 110mm SL A, dorsal and B, lateral views.

combinations of characters including the presence or absence of scales, number of vertebrae, the form of labial fimbriae, and both the extent and morphology of the cleithral flap and opposing horizontal fleshy subcleithral ridge.

Ichthyscopus barbatus Mees, 1960
(Figs 1B, 3B, 4B, 8A)

Ichthyscopus barbatus Mees, 1960: 49, figs 3, 4, 5a. Type locality – western coast of SW Australia between Rottnest I. and the Stragglers.

MATERIAL. New South Wales:- AMSIA245 (1, 142) off Norah Head, 33°17'S 151°37'E, 48-69m, 18 June 1921, F. McNeill & A. Livingstone; AMSI1875 (1, 227) off Port Jackson, 33°51'S 151°17'E, 128m, O. Meyer; AMSI3926 (1, 232) off Barrenjoey, 33°35'S 151°21'E, 51m, 1898; AMSI3927 (1, 198) off Broken Head, 33°27'S 151°34'E, 51m, 1898; AMSI18143-001 (1, 237) off Nelson Bay, 32°43'S 152°08'E, May 1974, Sydney Fish Markets; AMSI25863-001 (1, 187) south of Port Stephens, 32°49'S 152°02'E, 38-53m, 11 April 1985, FRV Kapala, K. Graham; AMSI34216-002 (1, 184) off Jervis Bay, 35°13'S 150°36'E, 23 February 1993, FRV Kapala, K. Graham; NMVA13018 (1, 130) Disaster Bay, 37°16.5'-37°16.8'S 149°59.1'-150°01.1'E, 24-33m, 11 August 1993, RV Southern Surveyor; South Australia:- SAM388 (1, 196) 33°46'S 133°30'E, 37m, 28 February 1981, T. Holder; SAM1065 (1, 130) 3 miles south of Evans I., 40m, 14 April 1982, K. & T. Olsen; SAM1111 (1, 143) 10.5-8.6 miles off Emu Bay, Kangaroo I., April-May 1981, I. Brown; SAM1204 (1, 118) 9.6 miles off Emu Bay, Kangaroo I., 31m, 27 January 1982, March & Bates; SAM1537 (1, 146) 5-5.5 miles off North Cape, Kangaroo I., 27-29m, 12 January 1982, I. Brown.

DIAGNOSIS. Dorsal fin with II spines and 17 or 17.5 soft rays, anterior end with low notch but not distinctly differentiated from rest of fin (Fig. 1B), 2nd fin ray element (= last spine) shortest,

FIG. 6. Dorsal surface of head in *Ichthyscopus nigripinnis*, paratype, QMI11908, 275mm SL, showing exposed bony surface.

elements becoming progressively longer posteriorly; posterior nostril circular (Fig. 4B); labial fimbriae simple, smooth-edged; skin flap on lower jaw adjacent to ventrolateral edge of lower lip with smooth margin (Fig. 3B), lacking fimbriae; each side of lower jaw with 2-9 teeth; chin with anteroposteriorly aligned pair of short barbels on symphysis; cleithral skin flap nearly twice length of cleithral spine; fleshy horizontal subcleithral ridge continuing on posterior side of pectoral fin axis to just below free posterior tip of cleithral skin flap, forming free pointed flap posteriorly; fleshy horizontal subcleithral ridge continuing on posterior side of pectoral fin axis only half way from base to tip of cleithral skin flap; crest of ridge fimbriate anterior and posterior to pectoral fin base; fimbriae on ridge anterior to pectoral fin base rather sparse, much simpler than fimbriae on opposing margin of cleithral flap, those posteriorly similar in structure to those of cleithral flap; scales present, in 28-45 oblique rows; sides with 2 broad dark saddles, positioned below anterior and posterior ends of dorsal fin; pectoral fin mostly dusky with pale distal margin and pale fleshy base.

DESCRIPTION. Dorsal fin rays II, 17 or 17.5; anal fin rays 16 or 16.5; caudal fin with 12 or 13 principal rays, 3-5 unsegmented procurrent rays dorsally and 1-4 unsegmented procurrent rays ventrally; pectoral fin rays 13-15 (usually 14); pelvic fin rays I, 5; vertebrae 9 + 17 or 18 (usually 9 + 17); epipleural ribs 8-11 (mean 9.50), situated on vertebra 4 or 5 - 11 to 14.

Body moderately deep, compressed posteriorly; head rather square in cross section (see Table 1 for morphometric data).

Head mostly encased in bone, without obvious joint lines dorsally; bony surface textured with fine low vermiculations; dorsal surface mostly flat, only slightly concave posterior to interorbital fossa. Interorbital fossa rectangular, width posteriorly slightly more than that between

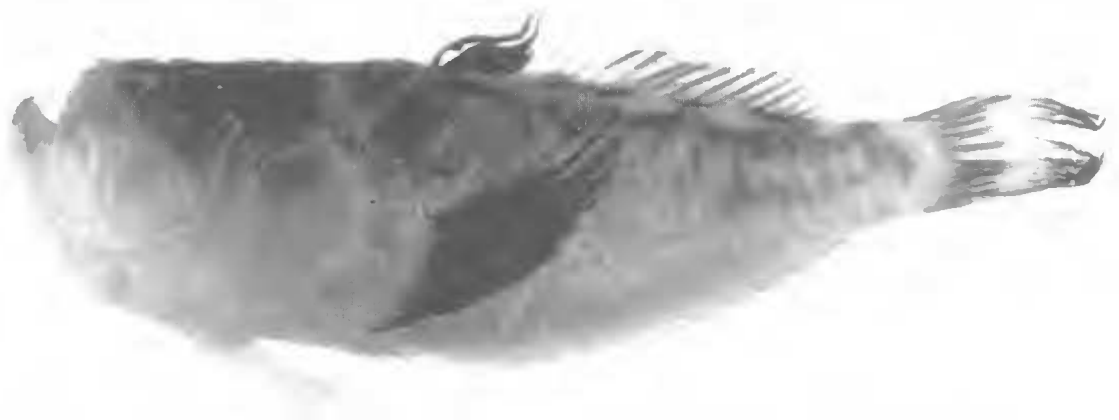

FIG. 7. Juvenile *Ichthyscopus nigripinnis* sp. nov., paratype, NMVA20080, 54.8mm SL, lateral view.

orbits. Orbit circular, diameter distinctly greater than that of eye. Anterior nostril small, approximately 1/3 eye diameter, tubular, somewhat divided into two openings by midposterior thickening or T-shaped flap; anterior side with low rim providing notch, rim edged mostly with simple to broad lobate fimbriae. Opening of posterior nostril circular, anterior lobe tall, narrow, with numerous simple fimbriae, mesial and lateral flaps not especially prominent, each with fimbriate edges. Both lips with simple, smooth-edged fimbriae externally, fimbriae on lower lip occasionally branched at corner of mouth; 17-23 individual fimbriae on upper lip, 41-52 on lower; skin flap on lower jaw adjacent to ventrolateral edge of lower lip with smooth margin, lacking fimbriae; inner edge of upper and lower lips also with very fine, often distinctly subbranched to palmate fimbriate fringe. Upper jaw with band of numerous small slightly curved teeth; teeth not in distinct rows, about 2 or 3 teeth across band where broadest. Lower jaw in large specimens usually with about 6-9 widely spaced straight prominent narrow canines angled back into mouth on each side, posteriormost noticeably longer than others. Oral valve broad, fleshy, drawn upwards into a tri-peaked rectangular flap medially. Chin smooth, with anteroposteriorly aligned pair of short barbels on symphysis, posterior barbel longer. Dorsal half of opercular margin fimbriate, with 21-31 individual fimbriae; ventralmost simple, those dorsally with up to 8 simple lateral branches, branches rarely subdivided; opercular margin smooth ventrally.

Cleithral spine extending posteriorly almost to above dorsal extent of pectoral fin axis. Fleshy cleithral skin flap enveloping spine extending well past this point; underside of flap fimbriate with 21-28 individual fimbriae; fimbriae, including that at tip with up to 9 side branches on both anterior and posterior margins, those closest to tip with most branches, branches only occasionally subdivided into sub-branches (occurring most often proximally on flap); occasionally 1 or 2 simple fimbriae on dorsal edge of flap near tip. Narrow fleshy subcleithral ridge extending horizontally from opercular opening to dorsal extent of pectoral fin base, continuing on posterior side of pectoral fin axis only half way from base to tip of cleithral skin flap; crest of ridge fimbriate anterior and posterior to pectoral fin base; fimbriae on ridge anterior to pectoral fin base rather sparse, much simpler than fimbriae on opposing margin of cleithral flap, those posteriorly similar in structure to those of cleithral flap. No spines associated with subopercle, opercle, preopercle or basipterygium.

Dorsal fin rather long-based and low, anterior end with low notch but not distinctly separated into distinct anterior segment, 2nd fin ray element (= last spine) shortest, varying from considerably (almost half) to only slightly shorter than subsequent element, following elements becoming progressively longer posteriorly. Anal fin long-based and low. Caudal fin broadly rounded. Pectoral fin pointed, tip of 3rd ray at point, membrane incised slightly between tips. Pelvic fins strong and fleshy, inner 2 rays longest, interradial membranes more clearly incised in remaining rays. Ventral midline with medial ventral skin flap from anterior tip of basipterygium to center of pelvic fin base.

Scales prominent, cycloid, rectangular, arranged in 28-45 obliquely angled rows, with or without additional scales scattered at posterior end of caudal peduncle, up to 10 scales across patch in at least one specimen; underside of body naked anteroventral to an imaginary line connecting tip of cleithral skin flap and center of anal fin base. Lateral line pores in lines or clumps of 3-8 at dorsal end of each diagonal scale row. Nape between rows of lateral line pores devoid of scales; sensory pores virtually absent from nape except for those associated with lateral line.

Colour in alcohol brownish grey dorsally on sides and head, creamy white below with 2 pairs of broad dark saddles, 1 at origin of dorsal fin, extending onto cleithral flap ventrally; 2nd on and beneath posterior end of dorsal fin, extending well ventrally. Opercle, preopercle and much of maxilla creamy white; broad rectangular dark blotch on cheek; upper lip, lower lip and chin brownish grey; interorbital fossa rather dark. Dorsal fin dusky except for dark extensions of saddles onto fin and pale margin. Anal fin creamy white with faint dusky mid lateral stripe posteriorly (nearer distal margin than base). Caudal fin mostly dusky with narrow pale distal margin, broad transverse band proximally and dusky blotch dorsally on fleshy base. Lateral surface of pectoral fin mostly dusky with pale distal margin and pale fleshy base; inner surface pale. Pelvic fins creamy white. Juveniles unavailable.

Colour in life (see Gomon, 1994, fig. 631) pale brown above, white below, dorsal portion of head reddish brown, cheeks dark brown; 2 broad dark brown saddles on upper part of body below dorsal fin, first near origin and second near termination of fin; caudal fin dark brown; anal fin white with

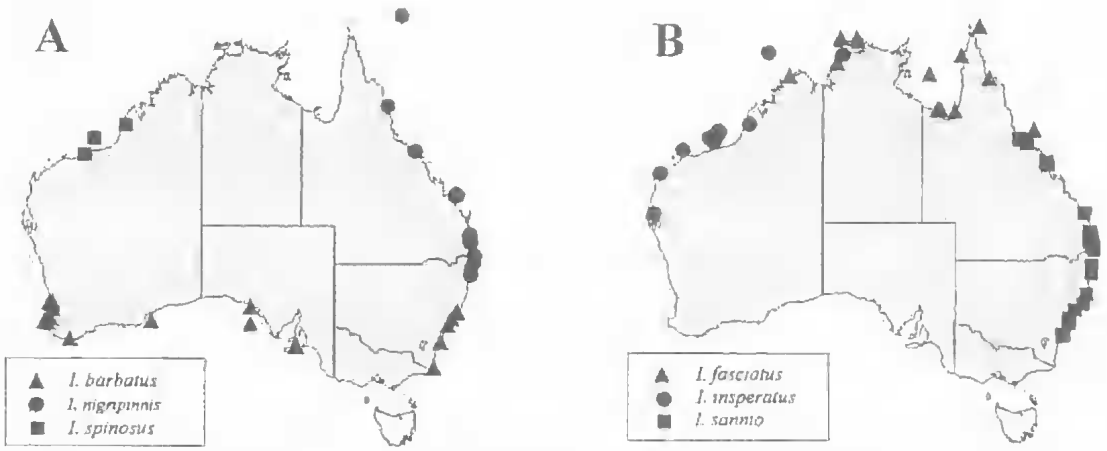

FIG. 8. Confirmed distributional records of A, *Ichthyscopus barbatus*, *I. nigripinnis* and *I. spinosus*, and B, *Ichthyscopus fasciatus*, *I. insperatus* and *I. sanmio*.

narrow cream basal and subdistal stripes; pectoral fins medium brown with white margin; pelvic fin white.

DISTRIBUTION. Restricted to the coastal waters of southeastern and southwestern Australia between about Nelson Bay (32°43'S 152°08'E) and Disaster Bay (37°16.8'S 150°01.1'E) in NSW, and from Rottnest I., WA (31°59'S 115°45'E) to Kangaroo I., SA (35°36'S 137°31'E) (Fig. 8A), at depths of about 24-130m.

REMARKS. The gap in the known distribution of this species between southern NSW and Kangaroo I. does not appear to be an artefact of sampling. Specimens examined from SE and SW Australia do not possess any recognisable differences. Major water current patterns in the regions where the disjunct populations occur are presently such as to make it doubtful that the populations are still genetically linked by larval dispersal. It is more likely that the populations were contiguous until some time between the last extreme interglacial period (approximately 122,000BP) and the last sea level minimum (approximately 20,000BP; Frakes et al., 1992), and that genetic drift has not occurred to the extent that the 2 populations have noticeably differentiated. Comparisons of proteins between populations have not been undertaken as fresh material is not readily available

Ichthyscopus fasciatus Haysom, 1957
(Fig. 8B)

Ichthyscopus fasciatus Haysom, 1957: 139, fig. 1. Type locality - Cleveland Bay, near Townsville, N Qld.

MATERIAL. Queensland:- QMI10703 (1, 102, holotype) Cleveland Bay, 6 June 1955, G. Coates; QMI11203 (1, 111) SE corner of the Gulf of Carpentaria, CSIRO, ~1961; QMI23532 (1, 113) North of Cape Bowling Green, 19°17.4'S, 147°21'E, 18m, 12 November 1985, Queensland Department of Primary Industries, Fisheries; WAMP5139-001 (1, 243) no locality; Northern Territory:- NTMS10108-004 (1, 240) Port Essington, 11°16'S 132°09'E, 24m; NTMS11187-001 (1, 168) Fog Bay, 13°06'S 130°15'E; NTMS12434-029 (1, 111) Cobourg Peninsula, 11°06'S 132°06'E, 22m; NTMS12445-012 (1, 86.4) Cobourg Peninsula, 11°06'S 132°04'E, 20m; NTMS-12536-001 (1, 119) Cobourg Peninsula, 11°06'S 132°04'E, 20m; Western Australia:- WAMP28457-001 (1, 119) Admiralty Gulf, 14°20'S 125°53'E, 14.6-18.3m, 26 April 1968.

DIAGNOSIS. Dorsal fin with I spine and 17.5-20 soft rays, anterior end not partially differentiated into anterior segment, anteriormost fin ray element shortest, elements becoming progressively longer posteriorly; posterior nostril circular, positioned in anterior gap in bony orbit; labial fimbriae with lateral branches; skin flap adjacent to ventrolateral edge of lower lip with smooth margin; each side of lower jaw with 11-18 teeth; chin lacking barbels, but with bony ridge on either side; cleithral skin flap developed only as narrow margin along ventral edge of spine, barely extending posteriorly beyond tip; fleshy subcleithral ridge absent; scales present, in 52-84 oblique rows; sides with 5 or 6 broad dark bands dorsally, 2nd to 4th bands extending onto dorsal fin; pectoral fin pale, upper edge with broad wash of slightly dusky pigment laterally.

DESCRIPTION. Dorsal fin rays I, 17.5-20; anal fin rays 17-18.5; caudal fin with 12 principal rays

and 5 or 6 unsegmented procurrent rays dorsally and ventrally; pectoral fin rays 15-16; pelvic fin rays 1, 5; vertebrae 9 + 18; epipleural ribs 8-10 (mean 9.11), situated on vertebra 4 or 5 -12 to 14.

Body moderately slender, compressed posteriorly; head rather square in cross section (see Table 1 for morphometric data).

Head mostly encased in bone, without obvious joint lines dorsally; bony surface textured with moderately rugose low irregular vermiculations; dorsal surface mostly flat, only slightly concave posterior to interorbital fossa; bony rim of orbits slightly raised posteromesially. Interorbital fossa rounded posteriorly, space somewhat constricted between eyes in small specimens, width posteriorly about 1.5 times that between eyes. Orbit circular, diameter distinctly greater than that of eye. Anterior nostril small, approximately 1/4 eye diameter, distinctly tubular, rim edged with simple fimbriae, single large bilobate flap midposteriorly, flap fimbriate in large specimens. Opening of posterior nostril circular, situated in anterior gap in bony orbit; nostril with anterior flap and smaller medial flap, each with fimbriate edges. Both lips fimbriate externally, fimbriae with 1 or 2 rows of up to 15 short, simple, evenly-spaced, lateral branches on either side, those in lower jaw better developed than in upper, branches occasionally bifurcate on fimbriae near symphysis of jaw, outer 3-5 fimbriae in lower jaw simple; 23-26 individual fimbriae on upper lip, 38-45 on lower; skin flap on lower jaw adjacent to ventrolateral edge of lower lip with smooth edge; inner edge of upper and lower lips also with fimbriate fringe, those in upper mostly simple, palmate in lower. Upper jaw with band of numerous small slightly curved teeth; teeth not in distinct rows, about 3 teeth across band where broadest. Lower jaw in large specimens with about 17 or 18 narrowly spaced short canines angled back into mouth on each side. Oral valve narrow with smoothly curved margin. Chin often with prominent lateral bony ridge on either side, ridge with extremely rugose to smooth surface (obscured by skin in some); symphysis smooth, without barbels; some with bony rugose patch laterally on expanded posterior end of maxilla and just below on lower jaw. Dorsal half of opercular margin fimbriate, with 11-18 individual fimbriae; most fimbriae simple, those dorsally with up to 5 irregular lateral branches; opercular margin smooth ventrally.

Cleithral spine extremely broad basally, with rugose lateral surface covered by skin, extending posteriorly almost to above dorsal extent of pectoral fin axis. Fleshy cleithral skin flap developed only as narrow margin along ventral edge of spine, barely extending posteriorly beyond tip; underside of flap edged with 8-14 mostly simple fimbriae. No narrow fleshy subcleithral ridge on pectoral fin base below cleithral flap. Upper half of opercle and preopercle with minute surface rugosity, similar in form but finer in texture than dorsal and cranial plates, lower halves with simple fine striae radiating ventrally. No spines associated with subopercle, opercle, preopercle or basipterygium.

Dorsal fin rather long-based and low, anterior end not separated into anterior segment; elements at anterior end of fin becoming progressively longer. Anal fin long-based and low. Caudal fin mostly truncate, only slightly rounded. Pectoral fin pointed, tip of 5th ray at point, membrane incised slightly between tips. Pelvic fins strong and fleshy, inner two rays longest, interradial membranes more clearly incised in remaining rays. Ventral midline with medial ventral skin flap from anterior tip of basipterygium to center of pelvic fin base.

Scales distinct, cycloid, rectangular, rather small, more or less arranged in 52-84 obliquely angled rows, in some specimens scales absent from anteriormost portion of sides (naked area reaching posteriorly to about center of pectoral fin in one specimen), rows angled obliquely forward from upper portion of sides in some, scales on caudal peduncle more perch-like in arrangement in some specimens; underside of body naked anteroventral to an imaginary line connecting tip of cleithral skin flap and center of anal fin base. Lateral line pores singular, each at posteroventral end of embedded tube. Nape between lateral lines devoid of scales; sensory pores virtually absent from nape except for those associated with lateral line.

Colour in alcohol whitish with 5 evenly spaced broad brown bands on dorsal third of sides, bands fading midlaterally, first crossing nape above cleithral spine and last positioned across caudal peduncle adjacent to proximal ends of caudal fin rays; upper surface of head and chin paler brown; slightly darker edged pale spot in interorbital fossa between anterior edges of eyes and two smaller spots of similar pigmentation on chin. Second band extending onto and covering anterior end of dorsal fin, 3rd and 4th bands also extending onto dorsal but not quite reaching distal edge; remainder of dorsal, as well as

caudal, anal, pectoral and pelvic fins pale; upper edge of pectoral fin with broad wash of slightly dusky pigment laterally. Juveniles as described for adults.

Colour in life (after Sainsbury et al., 1984, p. 267; Gloerfelt-Tarp & Kailola, 1984, p. 244; Allen & Swainston, 1988, fig. 819) fawn above, white below, with 5 or 6 dark brown bands across back to mid-sides, bands fading to indefinite yellow bands on ventral surface; nape brown. Haysom (1957) reported 'head is crossed by three irregular brown bands — the first, which is ill-defined across the snout, the 2nd just behind the eyes, and the 3rd, which is almost as dark as the body bands, across the occipital region' and Kailola (1975) described the interorbital fossa and chin as having 'oval, brown-edged white ocelli'); cleithral spine and fleshy ventral flap dark brown with yellow fringe; dorsal fin with dark brown extension of body bands and yellow margin; caudal, pectoral and pelvic fins bright orange or yellow with white bases and margins; pectoral with brown smudge centrally; anal fin white.

DISTRIBUTION. Restricted to the coastal waters of northern Australia and southern New Guinea between the Admiralty Gulf, WA (14°10'S 126°00'E) and Port Essington, NT (11°16'S 132°09'E) north to southern Irian Jaya (= south coast of Dutch New Guinea; Mees in Kailola, 1975) in the west and from the central portion of the Gulf of Carpentaria (14°00'S 138°36'E) through the Torres Strait (Coconut I., 10°03'S 143°06'E; Kailola, 1975) to Cape Bowling Green, Qld (19°17'S 147°21'E) in the east (Fig. 8B), at depths of about 9-24m.

REMARKS. *Ichthyscopus fasciatus* is the most distinctive species of the genus, having easily the least modified suite of characters. The fleshy skin flap associated with the cleithral spine is entirely confined to the ventral margin of the spine, barely extending posteriorly beyond its tip. The horizontal fleshy ridge on the base of the pectoral fin of its congeners is absent in *I. fasciatus* and fimbriae associated with the operculum and cleithral flap are the least developed of the species. Teeth of the lower jaw in this species are more similar to those of other uranoscopid genera, like *Uranoscopus* (Pietsch, 1989), in being rather short and numerous. This more than likely represents a primitive condition for the genus.

Ichthyscopus insperatus Mees, 1960
(Figs 3C, 8B)

Ichthyscopus insperatus Mees, 1960: 54, figs 8, 9. Type locality Roebuck Bay, NW Australia.

MATERIAL. Western Australia:- NMVA1909 (1, 116) North of Red Point, 18°42'-18°40'S, 119°37'-119°41'E, 114m, 12 March 1981, RV Hai Kung; WAMP4962-001 (1, 107) Shark Bay, 10 October 1960, R.J. McKay; WAMP8158-001 (1, 115) Shark Bay, 1964, Poole Brothers, 'Bluefin'; WAMP11839-001 (1, 33.0) Shark Bay, 19 October 1964, E. Barker; WAMP14808-001 (1, 177) Shark Bay, March 1965, A. McKenzie; WAMP27241-002 (1, 91.7) 18°44'S 119°26'E, 12 March 1981, N. Sinclair, 'Hai Kung'.

DIAGNOSIS. Dorsal fin with I spine and 18 or 19 soft rays, anterior end not differentiated into anterior segment, anteriormost fin ray element shortest, elements becoming progressively longer posteriorly; posterior nostril elongate, rimming fleshy anterior gap in bony orbit; labial fimbriae usually with numerous (up to 13) short tuberculate lateral branches; skin flap adjacent to ventrolateral edge of lower lip with smooth margin, usually with broad tab-like bulge on outer surface (Fig. 3C); each side of lower jaw with 9-14 teeth; chin without barbels; cleithral flap length twice that of spine; subcleithral ridge extending to about midpoint between tip of cleithral spine and tip of cleithral skin flap, forming free pointed flap posteriorly; crest of ridge with or without low mound-like flaps anterior to pectoral fin base, irregular posterior to it with fimbriate posterior tip, sometimes having fine irregular fimbriae on flaps in large specimens; scales absent; sides pale with 5 broad saddles on dorsal half of sides, saddles in smaller specimens in form of dark-edged 'halos', larger specimens with dark 'halos' less intense but with darker inner and outer edges, and ventral parts becoming faint leaving an impression of 9 or 10 dark edged vertical bands; pectoral fins pale with dusky hue centrally and somewhat posteriorly.

DESCRIPTION. Dorsal fin rays I, 18 or 19; anal fin rays 16 or 17; caudal fin with 12 principal rays, 3 or 4 unsegmented procurrent rays dorsally and 1-3 unsegmented procurrent rays ventrally; pectoral fin rays 14 or 15; pelvic fin rays I, 5; vertebrae 9 + 17 (rarely 9 + 16); epipleural ribs 8 or 9 (mean 8.40), situated on vertebra 4 or 5 – 11 or 12.

Body moderately deep, compressed posteriorly; head rather circular in cross section (see Table 1 for morphometric data).

Head mostly encased in bone, without obvious joint lines dorsally; bony surface textured with fine low vermiculations; surface visibly concave posterior to interorbital fossa. Interorbital fossa rectangular, width posteriorly only slightly more than that between orbits. Orbit somewhat rectangular, diameter distinctly greater than that of eye. Anterior nostril small, approximately 1/3 eye diameter, tubular, divided into 2 openings by T-shaped midposterior flap; anterior side with low rim providing notch, rim and posterior flap edged with simple to arborescent fimbriae. Opening of posterior nostril elongate, rimming fleshy anterior gap in bony orbit; low anterior, lateral and mesial flaps with arborescent fimbriae, posterior rim smooth; nostril not noticeably subdivided. Lips with numerous fimbriae externally, some with many (up to 13) short tuberculate branches on each side, those toward corners of mouth with shortest branches or without branches; 19 or 20 (34 in 1 specimen) individual fimbriae on upper lip, only 1 or 2 at each corner smooth-edged, 44-49 on lower with 11 or 12 at each corner smooth-edged; skin flap on lower jaw adjacent to ventrolateral edge of lower lip with smooth edge, usually with broad tab-like bulge on outer surface; inner edge of upper and lower lips also with fimbriate fringe, fimbriae only occasionally branched. Upper jaw with narrow band of numerous small slightly curved teeth; teeth not in distinct rows, about 2 or 3 teeth across band where broadest. Lower jaw in large specimens with 9-14 straight rather short but prominent narrow canines angled back into mouth on each side, 1 or 2 occasionally in a second row, posteriormost slightly longer than others. Oral valve broad, fleshy, drawn upwards into a low point medially. Chin smooth, without barbels. Dorsal half of opercular margin fimbriate, with 15-26 individual fimbriae; fimbriae branched except several simple at dorsal and ventral extremes, up to 4 or 5 lateral branches, some divided to base, best developed in large specimens; opercular margin smooth ventrally.

Cleithral spine extending posteriorly to above dorsal extent of pectoral fin axis. Fleshy cleithral skin flap enveloping spine, length of flap twice that of spine; underside of flap fimbriate with about 15-21 individual fimbriae; fimbriae often broad, with up to 4 or 5 side branches on both anterior and posterior margins including that at tip of flap, those closest to tip with most branches, branches only occasionally subdivided into sub-branches (occurring most often proximally on flap); up to 9 tuberculate fimbriae on dorsal edge of flap near tip. Narrow fleshy subcleithral ridge extending horizontally from opercular opening to dorsal extent of pectoral fin base, continuing on posterior side of pectoral fin axis about half way from tip of cleithral spine to tip of cleithral skin flap, forming free pointed flap posteriorly; crest of ridge irregular, with or without low mound-like flaps anterior to pectoral fin base and occasionally with flaps posterior to it, only posterior tip fimbriate in small specimens, mounds and flaps with fine irregular fimbriae in large specimens. No spines associated with subopercle, opercle, preopercle or basipterygium.

Dorsal fin rather long-based and low, anterior end not separated into anterior segment; rays progressively longer at anterior end of fin. Anal fin long-based and low. Caudal fin mostly truncate, only slightly rounded. Pectoral fin pointed, tip of 5th ray at point, membrane incised slightly between tips. Pelvic fins strong and fleshy, inner 2 rays longest, interradial membranes more clearly incised in remaining rays. Ventral midline with medial ventral skin flap from anterior tip of basipterygium to rear of pelvic fin base.

Scales apparently absent, although some faint skin folds reminiscent of diagonal scale rows sometimes visible. Lateral line pores in diagonal rows with 3-8 pores per row. Sensory pores otherwise absent from nape but obviously present posteriorly on bony head shield.

Colour in alcohol predominantly pale, slightly duskier dorsally with 5 broad saddles on dorsal half of sides, saddles in smaller specimens in form of dark-edged 'halos', centers having same pale hue as elsewhere; larger specimens with dark 'halos' less intense but with darker inner and outer edges, and ventral parts becoming faint leaving the impression of 9 or 10 dark edged vertical bands; first 2 'halos' continuous across nape and back, last 3 extending onto base of dorsal fin, viewed as complete ovals from side. Head slightly dusky dorsally with faint small darker marks in transverse row just behind posterior edge of interorbital fossa, and ocellated dusky reticulations on lips and anterior portion of membranous interorbital fossa. Dorsal fin pale with dark extensions of dark 'halos' and dark blotches marginally above and before 'halos' on body. Anal fin pale. Caudal fin pale with 2 broad dark bands, 1 a third of the way from base to tip and 2nd submarginally. Pectoral fins pale with dusky hue centrally and somewhat posteriorly. Pelvic fins pale. Juveniles pigmented as adults except dorsal surface of bony shield posterior to

eyes with 3 close set transverse bands, pigmented like, but much narrower than saddles on sides.

Colour in life (after Sainsbury et al., 1984, p. 267; Gloerfelt-Tarp & Kailola, 1984, p. 244; Allen & Swainston, 1988, fig. 820) grey-olive above, head with orange tints, white below; 10-12 dark brown narrow double cross-bands over back to mid-sides. Dorsal fin white with 3 or 4 broad oblique charcoal bands; anal and ventral fins white with yellow tints; caudal fin white with 2 or 3 crescentic charcoal bands; pectoral fin dusky with broad yellow margin.

DISTRIBUTION. Restricted to the coastal waters of northwestern Australia from about Shark Bay, WA (25°21'S 113°44'E) to about Darwin, NT (12°27'S 130°48'E) (Fig. 8B), at depths of 76-114m.

REMARKS. Scale development of most species in this genus is extremely variable with examples frequently having scale rows angled in the 'opposite' direction, scales scattered in a non-uniform fashion, especially on the caudal peduncle, or reduced to an imbricate condition resembling that of most perch-like fishes. The absence of scales in this species is merely an extreme example of the varying degrees of scale reduction seen in species like *I. fasciatus*, and does not warrant generic separation.

Ichthyscopus sannio Whitley, 1936
(Fig. 8B)

Ichthyscopus sannio Whitley, 1936: 45. Type locality – Patonga, Broken Bay, NSW.

MATERIAL EXAMINED. Queensland:- AMSI426 (1, 760); AMSI12550 (1, 142) Moreton Bay; AMSI16796-001 (1, 259) Fan Beach, Mackay, 21°09'S 149°12'E, 29 December 1972, J. Davies; AMSI21149-002 (1, 45) Bohle R. estuary, 19°12'S 146°42'E, 8 October 1965, F. Talbot & party; AMSI22769-008 (1, 96) Sarina Beach, north end, 21°24'S 149°19'E, 1-2m, 17 June 1980, G., M. & M. Hardy; AMSI22774-010 (2, 131-137) Alva Beach near Ayr, 19°27'S 147°29'E, 1-2m, 21 June 1980, G., M. & M. Hardy; AMSI23319-041 (1, 21) at mouth of Mangrove Ck E of Townsville, 19°16'S 147°03'E, 2m, 29 October 1982, D. Heese, D. Rennis; AMSI25687-001 (1, 168) Jumpin Pin, Stradbroke I., 27°44'S 153°26'E, 8 October 1984, C. Keenan; QMI1657 (1, 233) Moreton Bay, 27 January 1914, Campbell & Wickworth; QMI2196 (1, 95) Sandgate, Moreton Bay, 27°19'S 153°04'E, 5 October 1914, T.W. Grice; QMI4972 (1, 82) Sandgate, Moreton Bay, 27°19'S 153°04'E, 13 August 1932, R. Marchant; QMI5239 (1, 319) Mooloolaba, 26°41'S 153°07'E, 8 May 1935, Anderson; QMI6951 (1, 354) Surfers Paradise, 28°00'S 153°26'E, 24 June 1940, J. Thomson; QMI7026 (1, 385) Jumpin Pin, Stradbroke I., 27°44'S 153°26'E, 28 October 1940, C.E. Gilbert; QMI7719 (1, 276) Jumpin Pin, Stradbroke I., 27°44'S 153°26'E, 30 May 1947, A. Leonard; QMI7937 (1, 226) Tallebudgera Ck, 28°07'S 153°27'E, 26 February 1953, J. Bolton; QMI7995 (1, 196) Burleigh Hds, 28°05'S 153°27'E, 6 March 1955, J.B. Woodland; QMI8007 (1, 195) Burrum Hds, 25°11'S 152°37'E, 31 August 1955, A.E. Drimmer; QMI8229 (1, 191) Wilston Ck, Brisbane, 27°27'S 153°01'E, 4 September 1961, R. Ebrington; QMI8307 (1, 230) Tingalpa Ck mouth, Moreton Bay, 27°29'S 153°11'E, 16 June 1964, T.A. Strelow; QMI8308 (1, 231) off Birkdale, Moreton Bay, 27°29'S 153°13'E, 28 June 1964, J. Brooks; QMI9860 (1, 181) Coochin Ck mouth, Pumicestone Passage, 26°55'S 153°04'E, 5 January 1970, L. Glover; QMI11837 (1, 94) Bulwer, Moreton Bay, 27°05'S 153°22'E, 1950, K.E. Rowell; QMI12040 (1, 288) Lake Coombabah mouth, 27°55'S 153°21'E, 25 September 1951, E. Malmborg; QMI20958 (1, 431) Caloundra bar, 26°49'S 153°08'E, 1 May 1984, Redcliffe Trawler Seafoods; QMI26357 (1, 64) Caboolture R. mouth, 27°09'S 153°02'E, 5 November 1974, H. Weng; New South Wales:- AMSIA3567 (1, 235) Ballina, 28°52'S 153°34'E; AMSIA6309 (1, 210, holotype) Broken Bay, Patonga, 33°33'S 151°16'E; AMSIA6538 (1, 223) Nowra, Greenwell Point, 34°53'S 150°39'E, 9 December 1935, F. Rodway; AMSIB1363 (1, 151) Laurieton, 31°39'S 152°48'E, 1944; AMSIB2152 (1, 330) Nambucca Hds, 30°39'S 153°00'E, 1948; AMSIB2593 (1, 224) Laurieton, 31°39'S 152°48'E, 1950; AMSIB2794 (1, 108) South-West Rocks, 30°53'S 153°02'E; AMSIB3911 (1, 275) Sydney, Coal and Candle Ck, 33°38'S 151°13'E, 1958; AMSIB5072 (1, 208) Lake Macquarie, 32°59'S 151°35'E; AMSIB5085 (1, 164) Myall Lakes, Buladelah, 32°26'S 152°24'E; AMSIB5689 (1, 134) Ettalong Beach, 33°31'S 151°19'E, 1962; AMSIB6319 (1, 212) Kempsey District, Hat Head, 31°04'S 153°03'E; AMSIB6393 (1, 178) Botany Bay, Dolls Point, 34°00'S 151°08'E, 1963; AMSIB7787 (1, 150) Hawkesbury R., 33°35'S 151°10'E, 1967; AMSI2999 (1, 70,6) Newcastle, 32°56'S 151°46'E; AMSI5965 (1, 305) no locality, March 1903, J. Chimiery; AMSI7889 (1, 61.2) Lane Cove R., 33°47'S 151°08'E; AMSI13019 (1, 261) no locality, 5 March 1912, State Fisheries; AMSI15019 (1, 232) no locality, D. Stead; AMSI15020 (1, 230) no locality, D. Stead; AMSI15323-003 (1, 358) Smiths Lake, W of Horse Point, 32°19'S 152°28'E, 3m, 1968; AMSI15672-001 (1,219) Forster, Wallis Lake, 32°12'S 152°30'E, 1970; AMSI15749-001 (1, 247) Kilcare, 33°32'S 151°22'E, 5m, 1970; AMSI16847-021 (1, 21.3) ACT, Jervis Bay, Greenpatch Beach, 150°44'E 35°08'S, 1m, 24 June 1971, D. Pollard & P. Straw; AMSI19340-001 (1, 51.2) Clarence R., Palmers I., 29°27'S 153°17'E, 1975; AMSI19947-001 (1, 205) Hawkesbury R., Jerusalem Bay, 33°38'S 151°10'E, 5m, 1974; AMSI19948-009 (1, 32.2) Hawkesbury R., Jerusalem Bay, 33°38'S 151°10'E, 2m, 1974.

DIAGNOSIS. Dorsal fin with II or III spines and 16-17.5 soft rays, first 2 spines close together, often with tips projecting, 3rd spine much shorter, difficult to distinguish from enveloping skin or absent, a shallow concavity preceding soft rays only partially differentiating anterior part of dorsal fin into a short anterior segment (Fig. 1B); posterior nostril oval to circular, situated in

anterior gap in bony orbit; labial fimbriae with numerous short subdivided lateral branches (up to 16) on each side, branches longer distally; skin flap adjacent to lower lip smooth to distinctly crenulate; lower jaw with 12-21 teeth on each side; chin without barbels; cleithral skin flap slightly less than twice length of cleithral spine; fleshy horizontal subcleithral ridge continuing on posterior side of pectoral fin axis to just beyond half distance from tip of cleithral spine to posterior end of cleithral skin flap, forming a short free tip posteriorly; crest of subcleithral ridge discontinuous on opposing sides of pectoral fin axis, fimbriate along its length, fimbriae short, simple and closely spaced; scales present, in 47-59 oblique rows; a low blade-like skin flap along ventral midline from anus to midbase of pelvic fins; upper body with 2 poorly defined broad dark brown saddles positioned below dorsal fin anteriorly and posteriorly and with numerous irregular large white spots and blotches; nape and upper part of head with many small creamy-white spots.

DESCRIPTION. Dorsal fin rays II or III, 16-17.5 (usually III, 16.5), last element often small and very close to penultimate ray; anal fin rays 16.5-17.5 (usually 17.5), last element as in dorsal fin; caudal fin with 12 or 13 principal rays and 3-5 unsegmented procurrent rays dorsally and ventrally; pectoral fin rays 17 or 18 (usually 17); pelvic fin rays I, 5; vertebrae 9 + 18; epipleural ribs 7-9 (mean 8.08), situated on vertebra 4 or 5-11 or 12.

Body moderately deep, compressed posteriorly, head rather square in cross section (see Table 1 for morphometric data).

Head mostly encased in bone, without obvious joint lines dorsally; bony surface textured with fine low vermiculations; dorsal surface mostly flat, only slightly concave posterior to interorbital fossa. Interorbital fossa rounded posteriorly, width posteriorly slightly less than that between orbits. Orbit circular, diameter distinctly greater than that of eye. Anterior nostril small, approximately 1/3 eye diameter, tubular, rim edged by fimbriae with numerous branches, those anteriorly and posteriorly in clumps and somewhat thickened, those laterally slightly smaller and more flap-like. In juveniles, anterior nostril with fimbriae much less branched and midposterior flap prominent, extending forward to meet thickened inner edge of anterior fimbriae. Opening of posterior nostril oval to circular, situated in anterior gap in bony orbit; nostril anteromesially with 2 prominent thickened fimbriate flaps and usually several smaller branched fimbriae; nostril posterolaterally with low rim at fleshy margin of orbit, fimbriae here short, sparse and mostly simple, larger specimens with fine papillae inside nostril on inner margin. Both lips with numerous brush-like fimbriae externally in adults, fimbriae simple in juveniles; adult fimbriae with up to 16 rows of evenly spaced lateral branches on each side, each branch with up to 5 short tuberculate sub-branches; fimbriae occasionally bifurcate near symphysis of jaw; internally (beneath distal tip) all but outer 5-7 rows of fimbriae of upper jaw with a simple barbel, varying from short, tuberculate and poorly developed laterally, to elongate mesially; fimbriae of lower jaw with 1-3 simple to feebly branched elongate barbels internally on all but outer 8-15 fimbriae, those laterally shorter but thin and well developed; 27-36 individual fimbriae on upper lip, 41-51 on lower lip; skin flap on lower jaw adjacent to ventrolateral edge of lower lip with smooth to weakly crenulate margin in juveniles and small adults becoming distinctly crenulate medially in large specimens. Upper jaw with broad band of numerous small slightly curved teeth; teeth not in distinct rows, about 4 or 5 teeth across band where broadest. Lower jaw with 12-21 teeth on each side, including a group of small to minute teeth anteriorly (most clustered near symphysis), about 8-10 straight prominent canines angled back into mouth on each side, posteriormost canines noticeably larger, more broadly-based and strongly angled posteriorly. Oral valve broad, fleshy, drawn upwards into a low point medially. Chin smooth, without barbels. Dorsal half of opercular membrane fimbriate, with 12-19 individual fimbriae; ventralmost poorly developed and simple, those above flap-like with up to 10 variably arborescent branches; opercular margin smooth ventrally.

Cleithral spine extending posteriorly to or just beyond dorsal extent of pectoral fin axis. Fleshy cleithral skin flap enveloping spine extending well past this point, somewhat less than twice length of cleithral spine; underside of flap fimbriate with 15-22 individual fimbriae; fimbriae, including that at tip of flap with up to 12 subdivided arborescent branches on both anterior and posterior margins, dorsal edge of flap near tip smooth in juveniles but with up to about 12 small pointed feebly branched to simple brush-like fimbriae in large specimens. Narrow fleshy subcleithral ridge extending horizontally from

opercular opening to dorsal extent of pectoral fin base, continuing on posterior side of pectoral fin axis to just beyond midpoint between tip of cleithral spine and tip of outstretched cleithral skin flap, forming a short, free, pointed to fimbriate tip posteriorly; crest of ridge discontinuous at and just anterior to pectoral fin axis, fimbriate along most of its length, fimbriae short, simple and closely spaced, usually rather sparse anterior to pectoral fin base. No spines associated with subopercle, opercle, preopercle or basipterygium.

Dorsal fin rather long-based and low, anterior end partially separated into short anterior segment by shallow notch, first 3-4 elements relatively short, embedded in thick skin in large specimens, 3rd shortest, 4th longer than preceding elements; subsequent rays becoming progressively longer. Anal fin long-based and low. Caudal fin truncate to slightly rounded with branched tips of caudal rays extending slightly beyond membrane. Pectoral fin pointed, tip of 5th ray at point, membrane incised slightly between tips. Pelvic fins strong and fleshy, innermost ray longest, interradial membranes most clearly incised between first 4 rays. Ventral midline with prominent medial skin flap from anterior tip of basipterygium to rear of pelvic fin base, flap continuing posteriorly to anus, firstly as an inconspicuous low ridge but gradually deepening to form a thin blade-like flap.

Scales prominent, cycloid, rectangular, arranged in 47-59 (usually 50-52) obliquely angled rows (including smaller scales in less well defined rows on upper corner of caudal peduncle), occasionally two scale rows merging into one as they proceed ventrally; 8 of 25 specimens with patches of scale rows (usually below rear of soft dorsal or on caudal peduncle) directed dorsoposteriorly on one or both sides instead of typical ventroposterior pattern; additional small scales medially on upper half of caudal base (up to about 7 rows horizontally); peduncular scale rows from posterior end of anal fin base to distal corner of peduncle 16-20 (usually 17 or 18). Underside of body naked anteroventral to an imaginary line connecting terminal skin flap of subcleithral ridge to anterior 1/4 to 1/3 of anal fin base. Lateral line pores in angled lines or clumps of 1-4 at dorsal end of each diagonal scale row. Nape between lateral lines devoid of scales; sensory pores virtually absent from nape except for those associated with lateral line. Three to 4 smooth irregular-oval platelets, perforated by numerous pores, on upper 2/3 of caudal base immediately posterior to lateral scale rows, lower platelet largest.

Colour in alcohol dusky to dark brown on upper half of head and body, with irregular large pale spots and blotches, some with dark centers; an elongate pale blotch or stripe laterally below posterior end of dorsal fin extending to caudal base; 2 poorly defined dark saddles on sides (conspicuous in juveniles), first extending from origin of dorsal fin to about 4th dorsal fin element, 2nd at rear of dorsal fin base terminating at penultimate dorsal ray, both saddles reaching vertically to just below lateral midline of body. Nape, anterior half of cleithral skin flap, top of head, cheeks, lips and chin with numerous small close-set pale spots (less conspicuous on bony head shield), those anteriorly on head smallest; numerous small dark or dusky dots also scattered over this area. Cheek with large dark brown triangular blotch, distinct in juveniles, somewhat diffuse in larger specimens. Lower body and head including operculum pale. Dorsal fin dark with pale variegations forming irregular transverse bands, first 2-3 dorsal fin elements dusky to black, often with a pale spot at base of 1st spine and adjacent interspinous membrane. Anal fin pale, juveniles with diffuse dusky basal stripe on posterior half of fin and body adjacent to fin. Caudal fin pale to dusky with most of upper and lower margins and tips of rays distinctly pale; occasionally pale blotches or longitudinal bars centrally or posteriorly on fin. Pectoral fin uniformly pale basally; rays usually dark, occasionally pale, peppered with dusky melanophores; posterodorsal and ventral margins of fin pale, margins broad in juveniles. Pelvic fins pale, often with dusky melanophores on rays and a dusky tip posteromesially, the latter most prominent in juveniles.

Colour in life (see Grant, 1987, fig. 694a, 694b) as above, pale spots and blotches vivid to creamy white, dusky to dark areas brownish; lower portions of head, body and fins creamy white; operculum creamy white with flesh-pink tint; upper portion of body dark olive brown to light tan; saddles and triangular blotch on cheeks dark brown to dusky charcoal; caudal and margin of pectorals cream to yellow.

DISTRIBUTION. Restricted to the central coastal waters of E Australia between about Bohle River, Townsville, Qld (19°12'S 146°42'E) and Jervis Bay, NSW (35°08'S 150°44'E) (Fig. 8B), at depths of less than 10m.

REMARKS. Mees (1960) considered the Australian population described by Whitley (1936) as *I. sannio* to represent a subspecies of *I. lebeck* (Bloch & Schneider, 1801), the type of the latter from Tranquebar, India. He regarded the structure of the posterior nostril, the only feature in which he was able to discern differences in the 2 populations, not to be sufficiently significant as to warrant the recognition of the 2 as more than 'geographical races' (= subspecies). As specimens from China and Japan share a circular posterior nostril, Mees judged the northwestern and southwestern Pacific populations to be con-subspecific. We consider the 3 populations to be separate species, a notion supported by Kishimoto (pers. comm.) who has examined the taxa in greater detail. Mees provided a thorough synonomy for the Australian *I. sannio*.

Ichthyscopus sannio is separable from both the Indian Ocean and NW Pacific species in having 2 poorly defined broad dark brown saddles across the upper body (absent in northern hemisphere species), a distinguishable notch defining a somewhat separate anterior dorsal fin that is noticeably darker than the fin posteriorly in adults (not distinctively darker in the northern hemisphere species), and a smooth edge, rather than crenulations or tab-like cirri on the ventral opercular margin anterior to the pelvic fin bases. The Indian Ocean *I. lebeck* is distinctive within the genus in having the posterior nostril produeed posteromesially in the infraorbital space along the bony rim defining the mesial side of the orbit. The nostril reaches posteriorly to a point in line with the posterior margins of the orbits. In other species of *Ichthyscopus*, the nostril rarely reaches past the anterior margin of the orbit.

Ichthyscopus spinosus Mees, 1960
(Figs 2A, 8A)

Ichthyscopus spinosus Mees, 1960: 48, figs 1,2. Type locality – near Broome, northwestern Australia.

MATERIAL. Western Australia:- NTMS10959-020 (1, 134) N of Port Hedland, 80m, 18 April 1983, R. Williams, F/V Tung Mao; WAMP14325-001 (1, 165) 16 miles N of Port Hedland, 13 September 1965, H. Kalnins.

DIAGNOSIS. Dorsal fin with II spines and 17.5 soft rays, anterior end differentiated into short anterior segment by deep concavity in distal margin; 3rd element (= 1st soft ray) shortest, anterior segment dark with pale basal margin at least anteriorly; posterior nostril elongate, rimming fleshy anterior gap in bony orbit; labial fimbriae simple, smooth-edged; skin flap adjacent to ventrolateral edge of lower lip with smooth margin; each side of lower jaw with 4 to 6 teeth; chin lacking barbels; cleithral skin flap slightly less than twice length of cleithral spine; fleshy horizontal subcleithral ridge continuing on posterior side of pectoral fin axis from base nearly to tip of cleithral skin flap; crest of ridge irregular but not fimbriate; scales present, in 38-41 oblique rows; numerous small dark spots on upper portion of sides, head and on dorsal, caudal, anal and pectoral fins.

DESCRIPTION. Dorsal fin rays II, 17.5 (anterior elements slender, 3rd an unsegmented, unbranched 'soft ray' which is difficult to distinguish from preceding spines even with use of radiographs; 4th segmented but unbranched; last element shorter than penultimate element and associated with a reduced pterygiophore); anal fin rays 16; caudal fin with 12 principal rays and 3 unsegmented procurrent rays dorsally and ventrally; pectoral fin rays 16 or 17; pelvic fin rays I, 5; vertebrae 9 + 16; epipleural ribs 8, situated on vertebra 5-12.

Body moderately deep, compressed posteriorly; head rather square in cross section (see Table 1 for morphometric data).

Head mostly encased in bone, without obvious joint lines dorsally; bony surface textured with fine low vermiculations; dorsal surface mostly flat, only slightly concave posterior to interorbital fossa. Interorbital fossa rectangular, width posteriorly about 2/3 that between orbits. Orbit circular, diameter distinctly greater than that of eye. Anterior nostril small, approximately 1/4 eye diameter, tubular, divided into 2 openings by midposterior flap; anterior side with low rim providing notch, rim edged with moderately short simple to bilobed fimbriae. Opening of posterior nostril elongate, rimming fleshy anterior gap in bony orbit; nostril with prominent anterior flap and less prominent medial and lateral flaps, each with fimbriate edges; anterior flap functionally dividing nostril into lateral and mesial openings. Both lips with simple, smooth edged fimbriae externally, fimbriae on lower lip occasionally branched at corner of mouth; 25 or 26 individual fimbriae on upper lip, 52 to 55 on lower; skin flap on lower jaw adjacent to ventrolateral edge of lower lip with smooth margin; inner edge of upper lip with sawtooth margin, lower lip without inner fimbriate fringe. Upper jaw with broad band of numerous small slightly curved teeth; teeth not in distinct rows, about 3 or 4 teeth across band where broadest. Lower jaw in

large specimens with 4 to 6 prominent widely spaced straight narrow canines angled back into mouth on each side, posteriormost noticeably longer than others (smaller specimens with up to 8 or 9 teeth on each side of lower jaw). Oral valve broad, fleshy, drawn upwards into a low point medially (1 specimen with simple fimbriate margin). Chin smooth, without barbels. Dorsal half of opercular margin fimbriate, with 21 to 23 individual fimbriae; ventralmost fimbriae simple, those dorsally with up to 4 or 5 very short lateral branches, branches rarely subdivided; opercular margin smooth ventrally.

Cleithral spine extending posteriorly almost to above dorsal extent of pectoral fin axis. Fleshy cleithral skin flap enveloping cleithral spine extending well past this point; underside of flap fimbriate with 15-18 individual fimbriae, including several simple fimbriae anteriorly beneath opercular margin; fimbriae, including that at tip of flap, with up to 2 or 3 very short side branches on both anterior and posterior margins, those closest to tip with most branches, branches rarely subdivided into sub-branches. Narrow fleshy subcleithral ridge extending horizontally from upper angle of opercular opening to dorsal extent of pectoral fin base, continuing on posterior side of pectoral fin axis to just below free posterior tip of cleithral skin flap, forming short free pointed flap posteriorly; crest of ridge with several low bumps, sometimes also having a few simple slender papillae (Fig. 2A). Upper half of opercle and preopercle with low surface vermiculations similar in form but finer in texture than those on dorsal cranial plates; lower halves with simple fine striae radiating ventrally. No spines associated with subopercle, opercle, preopercle or basipterygium.

Dorsal fin rather long-based and low, anterior end partially separated into short anterior segment by concavity in distal margin; 1st 3 dorsal fin elements relatively short, 1st longest, 3rd shortest, 3rd about 4/5 length of 1st and 2nd and slightly more than 1/2 length of 4th; subsequent elements progressively longer. Anal fin long-based and low. Caudal fin truncate to slightly rounded with branched tips of caudal rays extending slightly beyond membrane. Pectoral fin pointed at tip of 5th ray, membrane incised slightly between tips. Pelvic fins strong and fleshy, inner 2 rays longest, interradial membranes more clearly incised in remaining rays. Ventral midline with medial ventral skin flap from anterior tip of basipterygium to rear of pelvic fin base. A small rounded transverse flap posteriorly at midbase of pelvics.

Scales prominent, cycloid, rectangular, arranged in about 38-41 obliquely angled rows, (including smaller scales in less well defined rows on upper corner of caudal peduncle), occasionally, 2 scale rows merging into 1 as they proceed ventrally. Underside of body naked anteroventral to an imaginary line connecting tip of cleithral skin flap and center of anal fin base. Lateral line pores in angled lines or clumps of 3-8 at dorsal end of each diagonal scale row. Nape between rows of lateral line pores devoid of scales; sensory pores absent from nape except for those associated with lateral line, between lateral lines at base of dorsal fin, those on naked skin adjacent to posterior margin of head shield and those piercing head shield posterolaterally.

Colour in alcohol pale brown dorsally on sides and head, white below, numerous deep brown spots with diameters ranging from pupil to eye size on dorsal half of head and body and on dorsal, caudal, anal and pectoral fins; spots on interorbital fossa, lips and chin smaller, some more or less joined to form wavy lines. Dorsal fin pale with dark anterior segment and several series of deep brown spots, comprising a row of rather large spots basally and smaller spots marginally; anterior segment with pale margin anteroventrally. Anal fin pale with midlateral row of small brown spots posteriorly. Caudal fin pale with several large brown spots proximally. Pectoral fin pale with scattered brown spots and tan blotch dorsally near base. Pelvic fins white. Juveniles unavailable. Colour in life unknown.

DISTRIBUTION. Recorded only from the coastal waters of central Western Australia in the region of Port Hedland (22°18'S 118°35'E) and Broome (17°58'S 122°14'E) (Fig. 8A); depth distribution of this species unclear as capture depth for museum specimens only available for 2 specimens (NTMS10959-020 and WAMP14325-001), 1 taken at 80m and the other, according to registration information, buried in an exposed sand bar when collected.

REMARKS. This species is known from only 4 museum specimens. Its rarity in collections is probably more reflective of limited sampling in both the geographical region and habitat where it occurs than the size of the population.

TABLE 2. Distribution of character states for selected variable morphological features in the 6 Australian species of *Ichthyscopus* and the genus *Uranoscopus*.

Character	*I. barbatus*	*I. fasciatus*	*I. insperatus*	*I. nigripinnis*	*I. sannio*	*I. spinosus*	*Uranoscopus*
Lower jaw teeth (many/few)	2	0	1	2	1	2	0
Labial fimbriae (absent/present)	1	1	1	1	1	1	0
Labial fimbriae (simple/branched)	0	1	1	0	1	0	variable
Upper labial fimbriae (few/numerous)	0	1	1	0	1	1	variable
Opercular margin (exposed/concealed)	1	1	1	1	1	1	0
Opercular margin (few/many fimbriae)	1	0	1	1	1	1	variable
Cleithral flap (not/well developed)	2	1	2	2	2	2	0
Sub-cleithral ridge (not/well developed)	1	0	1	2	1	2	0
Sub-cleithral ridge (no/many fimbriae)	2	0	1	2	1	1	0
First dorsal on anterior vertebrae (present/absent)	1	1	1	1	1	1	0
First dorsal (present/absent)	1	0	0	2	1	2	variable
Dorsal spines (0, 1, 2, 3)	2	1	1	3	2	2	variable
Number of pleural ribs (not reduced/ reduced)	1	1	1	1	1	1	0
Lateral line on caudal peduncle (unfused/fused)	1	1	1	1	1	1	0

OTHER MATERIAL EXAMINED

Ichthyscopus sp. JAPAN:- CAS-SU7015 (1, 257) Wakanoura, D. Jordan & J. Snyder; TAIWAN: CAS28205 (1, 48.1) South China Sea, SW of Kao-Hsiung, 70-90m, 13 October 1972, F. Steiner; MALAYSIA: CAS35867 (1, 163) Borneo, off Kuching, 40-50m, November, 1975, F. Steiner.

Ichthyscopus lebeck, INDIA: AMSB7519 (1, 220) Malabar, F. Day; CAS-SU41734 (1, 173) Madras Pres., Ennur Fisheries Station, January 1941, A.W. Herre.

RELATIONSHIPS AND BIOGEOGRAPHY

A comparison of 14 variable characters present in the Australian species of *Ichthyscopus* and *Uranoscopus* (Table 2) using PAUP yielded 2 trees having an equal shortest length of 22 steps with a consistency index of 0.909. A strict consensus of these 2 trees is presented as Fig. 9A, with the preferred tree as discussed below shown as Fig. 9B. As pointed out in the above discussion of *I. fasciatus*, the primitive structure of the fleshy flap on the cleithral spine, absence of any subcleithral ridge development in association with it, and the large number and uniform size of lower jaw teeth relative to those in other species of *Ichthyscopus* support an initial divergence of *I. fasciatus* from the line giving rise to the remaining 5 species, all sharing derivations of these features. A subsequent divergence of *I. insperatus* is supported by the absence of any sign of the differentiation of a dark anterior segment of the dorsal fin, as found in the remaining 4 species, a character which is likely to be a modification for that line. The succeeding divergence of *I. sannio* is supported by the larger number of lower jaw teeth relative to the remaining 3 species. This species also shares branched fimbriae on the lips with *I. fasciatus* and *I. insperatus* rather than having the simple fimbriae of the last 3. Even though the fringed character state may appear to be apomorphic because of its complexity, it is more likely to be primitive for the genus and determined by the nature of the substrate in which the species regularly bury themselves. Although the distribution of characters in *I. barbatus*, *I. nigripinnis* and *I. spinosus* do not provide a clear indication of relationships in the analysis, the greater development of the unique subcleithral ridge and better developed anterior segment of the dorsal fin in *I. nigripinnis* and *I. spinosus* support a paired relationship of the 2 (Fig. 9B). Despite the remarkable similarity of pigmentation in *I. barbatus* and *I. nigripinnis*, the general elements of the pattern (i.e. dark saddles on the body) are also present to some degree in both *I. spinosus* and *I. sannio*, suggesting they are features that occurred in the ancestor of all four.

Although the two northern hemisphere species of *Ichthyscopus* were not included in this analysis, a superficial examination of specimens of both indicates they are likely to constitute a monophyletic line which diverged after the separation of *I. insperatus*, but prior to the divergence of *I. sannio*. This is supported by the absence of any development of a separate

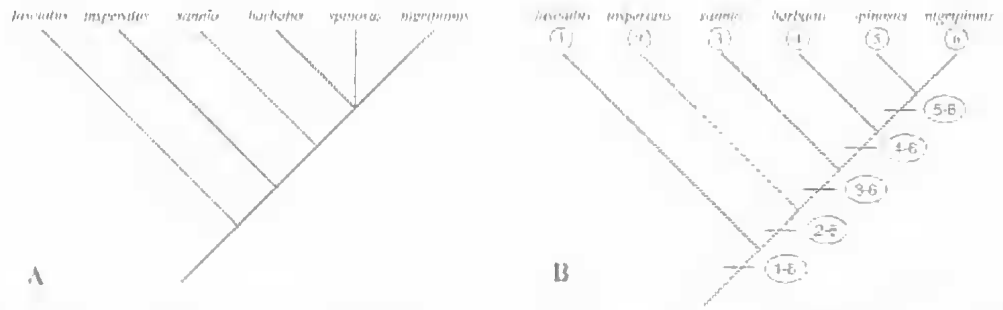

FIG. 9. Hypothesised relationships of Australian species of *Ichthyscopus* relative to the arbitrary outgroup *Uranoscopus* A, strict consensus, and B, preferred.

anterior segment of the dorsal fin in the first two, which is present in *I. sannio* and subsequently diverging species. Still, the presence of a darkened area at the anterior end of the dorsal fin in a 43mm SL specimen of the NW Pacific species may represent the first stages of this development. The two northern hemisphere species share a unique crenulated margin on the opercular membrane anterior to the pelvic fin bases, which is best developed in *I. lebeck*. This feature is absent in Australian species.

Unlike the speciose genus *Uranoscopus* with its numerous true tropical representatives, most if not all species of *Ichthyscopus* are, at the very least, antitropical in distribution. None of the species occur in both the southern and northern hemispheres. The genus *Astroscopus* hypothesised by Pietsch (1989) as sharing an immediate common ancestry with *Ichthyscopus* is similar in this regard, although one of the two recognised Atlantic species and the sole Pacific representative is reported to occur on both sides of the equator. Judging from the current distribution of the species in these two genera with the majority of the species of *Ichthyscopus* confined to Australasia, it is likely that the ancestor common to the two taxa had a southern hemisphere distribution. It is also likely that the New Zealand genus *Genyagnus*, thought to share an immediate common ancestry with the *Astroscopus*/*Ichthyscopus* line (Pietsch, 1989), diverged at about the same time. The establishment of the Southern Sub-Tropical Convergence as a result of the expansion of the Antarctic ice cap in the late Miocene (~ 5 million years before present) had major biogeographical affects (Frakes et al., 1992) and may have been involved. It is noteworthy that apart from *Uranoscopus* and the two genera, *Astroscopus* and the recently described, monotypic *Selenoscopus* (Okamura & Kishimoto, 1993), which are equally diverse in the two hemispheres, the greatest diversity of stargazer genera is in the southern hemisphere (and more specifically the Australasian region), with two of the five, the monotypic *Genyagnus* and *Pleuroscopus*, totally confined to southern latitudes.

The relatively localised distributions of *Ichthyscopus* species may provide an insight into at least one mechanism for speciation in the Australian region. Of the six Australian species, two are confined to the west coast of Australia and two to its east coast, with a fifth traversing the northern coast and the sixth distributed in the south (Fig. 8). The southern species spanning the width of the Australian continent has a disjunct distribution which may lead to differentiation in the future. The absence of any species of the genus in equatorial or cold temperate waters suggests that temperature is at least in part a factor affecting the extent of distribution. This affect is also apparent in the ranges of east and west coast species. It is likely that periods of latitudinal shift in isotherms associated with periodic cooling and warming of southern waters have driven populations possessing discrete temperature tolerances northwards and southwards along the Pacific and Indian Ocean coasts of Australia. Cycles of climatic fluctuations have occurred at approximately 100,000 year intervals through the late Quaternary with the last major interglacial period having taken place about 122,000 years ago (Frakes et al., 1992). Although historical patterns of water mass circulation in the Indian and Pacific Ocean basins are far from clear, it is likely that, as today, population expansions into southernmost or northernmost waters have been able to proceed more easily in an easterly or westerly direction depending on conditions of water movement existing at the time. Thus populations on either side of the continent when forced into southern or northern latitudes may not have had the same likelihood of reaching the opposite coast.

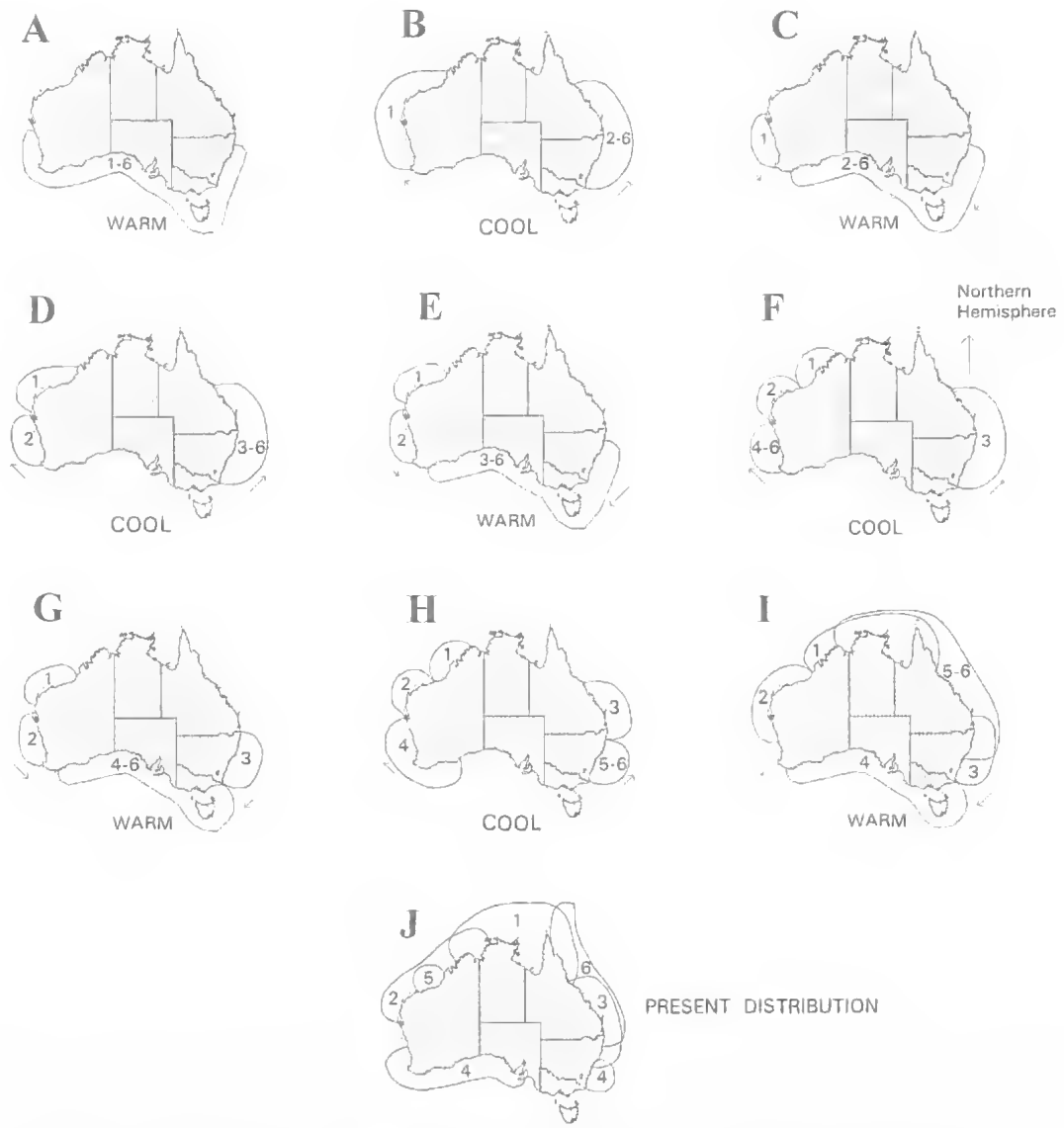

FIG. 10. Hypothesised sequence of ancestral distributions A-I, effected by periodic warming and cooling events in the Southern Hemisphere, leading to current species distributions, J. Numbers on distributional ranges of populations correspond with those of Fig. 9B.

With respect to the species relationships represented in Fig. 9B, the presence of the initial two diverging species, *I. fasciatus* and *I. insperatus*, in tropical, northwestern Australian waters, but the absence of *I. insperatus* or a sister taxon from northeastern waters supports an hypothesis that the southern coast was the side of the continent involved in the east-west expansion of populations. Likewise, the absence of any further speciation of the *I. fasciatus*-line (assuming that extinction did not occur) points to an historic presence in the northwest and only a recent expansion of the range of this species into the Pacific. An hypothesis of sequential changes in population distributions and the subdivision of populations caused by periodic warming and cooling shifts in southern hemisphere climates would explain the current distribution of taxa as presented in Fig. 10. Numbers superimposed on populations represented in this figure correspond with those in Fig. 9B. Although this is not the only hypothesis which would account for current distributions, it

requires no extinctions and assumes that all but the present longitudinal range expansion occurred across a single (the southern) coast.

If *I. sannio* is indeed the species closest to the Japanese and NE Indian Ocean taxa as has been implied by previous treatments of this genus, the transgression of an equatorial barrier by this taxonomic line is likely to have occurred prior to the differentiation of *I. nigripinnis* and *I. spinosus*, and perhaps that of *I. barbatus* (Fig. 10F). In addition, it is likely that this transgression took place in the W Pacific, accompanied by a subsequent expansion of the NW Pacific population into the Indian Ocean. The last hypothesis is supported by the presence of numerous other anti-tropical east Australian/ Japanese cognate species pairs which lack close relatives in the NE Indian Ocean. Many of these cognates have only recently been recognised as specifically different.

The greater latitudinal range of *I. nigripinnis* relative to shallower dwelling species in the genus, especially *I. sannio*, with which it is geographically sympatric, may be associated with its rather deep bathymetric distribution and the greater continuity of suitable habitats with relatively little temperature fluctuations which are present at greater depths. This penchant for deep cool waters is shared by *I. barbatus*. The virtual absence of information on the ecological propensities of *I. spinosus* makes it difficult to assess the hypothesis that this form of distribution is an ancestral trait.

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